

**Fear of Re-injury and other Intrinsic Factors are
Associated with Return to Sport after Anterior Cruciate
Ligament Reconstruction**

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BSc Physiotherapy (Wits)

Thesis presented in fulfilment of the requirements for the degree of

Master of Physiotherapy

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March 2015

DECLARATION

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Signature:

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ACKNOWLEDGEMENTS

I would like to thank the following people for their valuable contribution to this study:

- My study supervisor, Prof. Quinette Louw for her constant guidance and encouragement.
- Amanda Clifford, University of Limerick, Ireland, for co-authoring my manuscripts.
- Prof. Donald Skinner for his assistance with qualitative analysis.
- Nurjahaan Firfirey for her assistance with the screening of studies.
- Clinton Haley for IT assistance, his love and encouragement.
- Simone Jacobs for her assistance with translation and editing.
- Dr Firer and Dr Gelbart for consenting to the inclusion of their patients in the study.
- My family for their love and support.

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SUMMARY

The anterior cruciate ligament is the most commonly injured ligament in the knee, with only one third of athletes returning to their pre-injury level of sport. Identifying intrinsic factors associated with an increased likelihood of return to sport may improve the surgical outcome. A systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines was performed. The objective was to systematically appraise publications describing intrinsic factors which may be associated with return to sport, after anterior cruciate ligament reconstruction. A comprehensive eligibility checklist was composed. Methodological quality appraisal of cohort studies revealed that high quality studies were included in the review. A descriptive synthesis of the findings associating intrinsic factors with return to sport was performed. Ten studies were included. The most important finding was the association of fear of re-injury preventing return to sports participation. Knee function did not always correspond with the likelihood of returning to sport. Younger athletes and competitive, male athletes appeared more likely to return. Across these studies, the 141 athletes not returning to pre-injury sport were questioned as to the reason for non return. An average of 35% (49 athletes) cited fear of re-injury as the reason. Fear of re-injury was thus investigated further as it could be considered in the post-operative management of anterior cruciate ligament reconstruction. In a qualitative study with supplemental cross-sectional analysis, factors informing fear of re-injury were explored. Male and female athletes, aged 17-50 years were included (n=59). Reconstruction procedures using any graft type were included; however revision and multi-ligament reconstruction was excluded. Twenty-four participants (41%) did not return to the pre-injury sport. Those citing fear of re-injury as the only reason for not-returning to sport were interviewed (n=12). Thus,

those who did not return to pre-injury type and level of sport despite good knee function. Athletes' experiences informing fear of re-injury were explored by semi-structured interviews. Data analysis was performed by content analysis. Codes were allocated and categorised and these categories were synthesised into themes. The Qualitative review guidelines – RATS were followed. From the participant interviews, four themes emerged: undergoing the surgery and recovery again, nature of the pre-injury sport imposing risk of re-injury, personality traits, and social priorities. An accelerated rehabilitation programme was suggested to improve the post-operative experience. The supplementary analysis revealed athletes younger than 20 years of age were more likely to return to sport. Modifiable fears include pain, length of rehabilitation, mechanism of injury and psychological aspects. Pain management, motivation and education are important considerations post-operatively and during rehabilitation. Clinicians should be aware of factors informing fear of re-injury on an individual basis to develop a tailored management plan.

OPSOMMING

Die anterior kruisligament is die mees algemeen beseerde ligamente in die knie, met slegs een derde van die atlete wat terugkeer na hul pre-besering vlak van sport. Identifisering van intrinsieke faktore wat verband hou met 'n verhoogde moontlikheid van terugkeer na sport kan die chirurgiese uitkoms verbeter. 'n Sistematiese oorsig wat die Voorkeur Verslag Items vir Sistematiese oorsig en Meta-ontledingsriglyne volg, is uitgevoer. Die doel was om stelselmatig publikasies, wat intrinsieke faktore beskryf wat verband hou met terugkeer na sport na anterior kruisligament rekonstruksie, te beoordeel. 'n Omvattende kontrolelys is saamgestel. Metodologiese kwaliteit beoordeling van 'n groep studies het 'n hoë gehalte studie aan die lig gebring, wat ingesluit is in die oorsig. 'n Beskrywende sintese van die bevindinge wat intrinsieke faktore met die terugkeer na sport assosieer, is uitgevoer. Tien studies is ingesluit. Die belangrikste bevinding wat terugkeer na sportdeelname verhinder was die vrees van herbesering. Kniefunksie het nie altyd ooreengestem met die moontlikheid van terugkeer na sport nie. Jonger atlete en wedywerende manlike atlete was meer geneig om terug te keer. In al die ingesluite studies, is die 141 atlete wat nie teruggekeer het na sport voor-besering ondervra oor die rede vir nie terugkeer. 'n Gemiddeld van 35% (49 atlete) het vrees vir herbesering as rede aangevoer. Vrees vir herbesering is dus verder ondersoek, as oorwegende faktor in die post-operatiewe bestuur van anterior kruisligament rekonstruksie. In 'n primêre, kwalitatiewe studie met aanvullende deursnee-analise, is die redes vir die vrees vir herbesering ondersoek. Manlike en vroulike atlete, tussen die ouderdomme van 17-50 jaar is ingesluit (n = 59). Rekonstruksie prosedures deur enige soort oorplanting is ingesluit; hersiening en verskeie ligament rekonstruksie is egter uitgesluit. Vier-en-twintig deelnemers (41%) het nie teruggekeer na die pre-besering sport nie. Diegene wat vrees vir herbesering as die enigste rede vir nie terugkering na

sport aanvoer, is onderhoude mee gevoer (n = 12). Dus, diegene wat nie teruggekeer het na pre-besering, tipe en vlak, van sport ten spyte van goeie knie funksie. Die redes vir die vrees vir herbesering is ondersoek deur semi-gestruktureerde onderhoude. Data-analise is uitgevoer deur die inhoud / tematiese analise. Kodes is toegeken en gekategoriseer. Hierdie kategorieë is herverdeel in temas. Uit die deelnemer onderhoude, het vier temas na vore gekom: die operasie en herstel proses, die aard van die pre-besering sport as risiko vir herbesering, persoonlikheidseienskappe en sosiale prioriteite. 'n Versnelde rehabilitasieprogram is voorgestel om die post-operatiewe ervaring te verbeter. Die aanvullende analise het getoon dat atlete jonger as 20 jaar oud meer geneig was om terug te keer na die sport. Aanpasbare oorsake van vrees sluit in pyn, die lengte van rehabilitasie, meganisme van besering en sielkundige aspekte. Pyn bestuur, motivering en opvoeding is belangrike oorwegings post-operatief en tydens rehabilitasie. Dokters en fisioterapeute moet bewus wees van die vrees vir herbesering en die veranderbare oorsake daarvan ondersoek op 'n individuele basis om 'n pasient spesifieke bestuursplan te ontwikkel.

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GLOSSARY OF TERMS AND ABBREVIATIONS

ACL-RSI	Anterior Cruciate Ligament-return to sport after injury scale
Anterior drawer test	Tests the integrity of the ACL
CI	Confidence Interval
KOOS	Knee Injury and Osteoarthritis Outcome Score; consist of 5 subscales i.e. pain, symptoms, daily living, sport, knee-relate quality of life
Lachman test	Tests the integrity of the ACL
Lysholm scale	Measures knee function, symptoms and disability by 8 components
Marx activity scale	Measures the frequency patients are able to perform tasks which would be difficult with a pathological knee condition
Noyes scale	Measures activity level
Objective IKDC	Incorporates knee effusion, knee range of movement and ligament stability
OR	Odds Ratio
Pivot shift test	Tests the integrity of the ACL
RR	Relative Risk
SD	Standard deviation
SRLC	Sport Rehabilitation Locus of Control scale
Subjective IKDC	International Knee Documentation Committee; subjective evaluation form contains 10 items related to knee symptoms and physical functioning
Tegner Activity Scale	An 11 point scale for work and sports activities
TSK	Tampa Scale of Kinesiophobia; scores range from 11-44 with higher scores indicating more fear of movement

CHAPTER 1

Introduction

The anterior cruciate ligament (ACL) is the most commonly injured ligament in the knee and highly prevalent in adolescents and adults participating in pivoting sports (Arder, Webster, Taylor & Feller, 2011). To diagnose this injury, the Lachman test is most accurate with the anterior drawer test and pivot shift test also performed. An MRI may confirm the diagnosis (Meuffels et al., 2012). Conservative management may be recommended for older athletes or athletes dropping to a lower level of sport, after the symptomatic instability reduces with physiotherapy (Meuffels et al., 2012). These athletes are defined as “copers” (Hartigan, Axe & Snyder-Mackler, 2012). However, conservatively managed ACL injuries have a higher risk of developing osteoarthritis in the knee joint (Spindler et al., 2012). Of conservatively managed ACL injuries, one third suffer subsequent meniscus damage and one third require reconstruction at a later stage (thus known as “noncopers”) (Spindler et al., 2012).

Athletes desiring to return to sports or activity level which would be impossible with an unstable knee, undergo reconstruction of the ACL (Smith, Rosenlund, Aune, MacLean & Hillis, 2004). The surgery should take place once the synovial reaction has settled and optimal knee function, particularly full extension, has been regained (Meuffels et al., 2012). Therefore pre-operative physiotherapy may be beneficial to regain range of motion and commence strengthening as this will improve post-surgical outcomes (Adams, Logerstedt, Hunter-Giordano, Axe & Snyder-Mackler, 2012). Post-operative physiotherapy aims to maintain full knee extension, thus preventing arthrofibrosis and

future strain on knee structures (Adams et al., 2012). After harvesting a hamstring graft, the hamstring muscle retracts which may further contribute to loss of full knee extension. Stretching of the hamstring is thus recommended. A quadriceps strength deficit of 15%-40% is highly prevalent post reconstruction, thus strength training is an important goal and may be facilitated by neuromuscular electrical stimulation.

Guidelines for exercise progression differ slightly between surgeons and cases, and concurrent injuries such as meniscal damage must be considered. The following guidelines pertain to a primary ACL reconstruction excluding concurrent injuries or revision. After two-three weeks, the use of crutches may be reduced and closed-chain activities such as wall slides and step-ups may be done, as open-chain exercises will lead to laxity of a hamstring graft if done at this stage (Meuffels et al., 2012). If a hamstring graft has been used, resisted hamstring exercises are avoided for 12 weeks post surgery (Meuffels et al., 2012). Regaining range of movement is important and accessory mobilization of the patello-femoral joint can be useful in addition to active and passive exercises of the knee joint (Adams et al., 2012). After two-four months, the rehabilitation focuses on running, lower extremity strengthening and neuromuscular control (Cascio et al., 2004; Meuffels et al., 2012). Hurd, Axe & Snyder-Mackler (2009) suggested that once athletes are able to run on the treadmill for 15-20 minutes, they may progress to on-field training.

Light intensity sport can commence from four to five months after surgery, with sport specific drills and moderate intensity sport commencing at six months (Cascio et al., 2004; Petersen & Zantop, 2013), however some guidelines recommend sport-specific drills from twelve weeks (Adams et al., 2012). Return to pre-injury sport is recommended from six-twelve months post-surgery (Meuffels et al., 2012) but as early as four months

in some literature (Della Villa et al., 2012). Current return to sport criteria include achieving 90% on functional assessments including quadriceps strength index, single hop test and self-reported knee function (Hartigan, Axe & Snyder-Mackler, 2010).

Return to sports (RTS) participation, at the pre-injury level, is considered an indicator of the success of ACL reconstruction (Feller & Webster, 2013), however a recent systematic review (SR) reports that after ACL reconstruction, 81% return to some form of sports participation, 65% return to pre-injury level of sport and 55% return to competitive sport (Ardern, Taylor, Feller & Webster, 2014). This relatively lower RTS rate remains challenging and reasons for sport cessation post ACL reconstruction are insufficiently described (Grindem, Eitzen, Moksnes, Snyder-Mackler & Risberg, 2012). Two published SR's broadly investigated variables associated with RTS (Ardern et al, 2014; Czuppon, Racette, Klein & Harris-Hayes, 2014). The studies reviewed were of heterogeneous design and variable methodological quality. No difference in RTS rate between graft types has been found and there is little evidence describing tunnel placement, graft orientation and tibial rotation with RTS rate (Feller & Webster, 2013). Further investigation of factors associated with RTS is thus required.

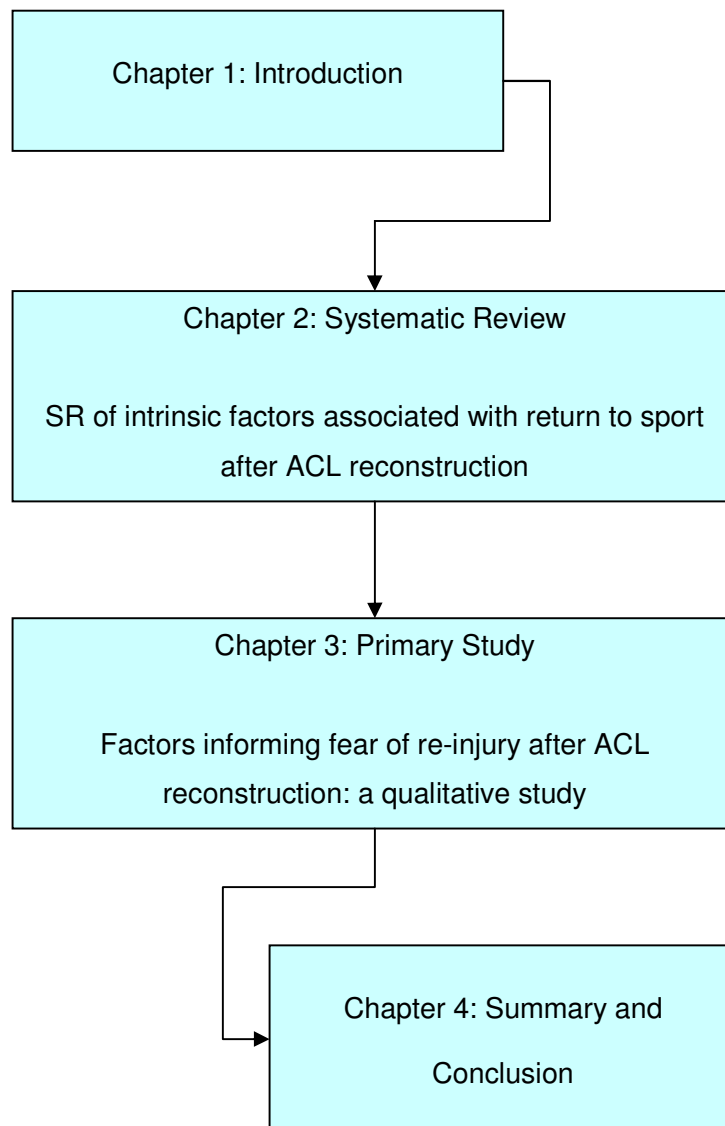
Failure to meet the above RTS criteria due to ongoing knee pain or functional problems is one cause of sport cessation. However personal and psychological reasons also exist (Devgan, Magu, Siwach, Rohilla & Sangwan, 2011). Fear of reinjury of either the operated knee or the contra-lateral knee has been cited as a common reason for not returning to sport (Ardern et al., 2014; Czuppon et al., 2014). Fear of re-injury may be present, despite good knee function. To our knowledge, there is no published research specifically exploring what informs fear of re-injury post ACL reconstruction.

Most athletes undergoing ACL reconstruction aim to return to some form of sports participation, if not competitive sport (Feller et al., 2012). Discovering which factors are associated with an increased likelihood of returning to sport can assist athletes in achieving their goal. Further understanding of factors informing fear of re-injury will be valuable as it can be employed in the post-operative management and rehabilitation. Thus, new information related to the attrition of physical activity post ACL reconstruction will benefit both athletes and clinicians in achieving the pre-operative aim of the reconstruction; return to sports participation.

The two main aims of this study are:

1. To systematically appraise all the evidence for intrinsic factors exclusively, and their association with RTS participation at the pre-injury level.
2. To explore factors informing fear of re-injury post ACL reconstruction in athletes who cited fear as the sole reason for not returning to the pre-injury level of sport.

This thesis will follow the publication format as Chapters 2 and 3 have been submitted for publication to the International Journal of Sports Medicine and Physical Therapy in Sport, respectively. The format guidelines for these journals are attached in Appendix 7. The references of the SR were changed to the Harvard referencing system to maintain consistency throughout the thesis. The outline is displayed in Figure 1.



SR = Systematic review

ACL = Anterior Cruciate Ligament

Figure 1: Flow chart of thesis outline

CHAPTER 2

Intrinsic Factors Associated with Return to Sport after ACL Reconstruction: A Systematic Review

2.1 INTRODUCTION

The anterior cruciate ligament (ACL) is the most commonly injured ligament in the knee, resulting in devastating effects for the athlete (Ardern et al., 2011). Loss of knee stability may impair activity levels and for many, have psychological and social implications of questionable return to sport (RTS) (Grindem et al., 2012). Appropriate management of ACL injuries is important to facilitate RTS. Conservative management is indicated in athletes not involved in pivoting sports, or for those returning to a low level of physical activity (Grindem et al., 2012). However, surgical reconstruction of the ACL is required when conservative management has failed, or for whose RTS would be impossible with an unstable knee (Smith et al., 2004). Irrespective of the type of management, RTS after this common injury remains challenging (Grindem et al., 2012). Published papers indicate that on average after twelve months, 81% of athletes have returned to some form of sports participation and 55% have returned to competitive sport (Ardern et al., 2014).

Factors that indicate a likelihood of returning to sport are therefore important (Feller et al., 2013). Clinicians and coaches can access these factors and intervene to optimise an athlete's chances of returning to sport. Extrinsic factors, originating outside the body, such as surgical procedure, rehabilitation protocols, sporting equipment and sport-

specific coaching, may influence RTS. Rehabilitation pre-and-post ACL surgery is imperative to facilitate timely and safe RTS (Cascio, Culp & Cosgarea, 2004). To assist RTS, exercises such as running, strength training, proprioception and light intensity sport can commence from four to five months after surgery, with sport specific drills and moderate intensity sport commencing at six months (Cascio et al., 2004; Petersen & Zantop, 2013). Extrinsic factors are influenced by many personal and contextual factors and have been investigated by numerous studies (Engelman, Carry, Hitt, Polousky & Vidal, 2014; Kim, Seon & Joe, 2013; Saka, 2014).

Intrinsic factors, which are inherent to the athlete, include age, gender, height and body weight (BMI), muscle strength, flexibility, level of motivation to comply with rehabilitation, fear of re-injury, associated injuries to the knee or other lower limb joints, joint integrity on injury and previous injury or tear to the ACL. It is unclear whether these intrinsic factors relate to RTS post ACL reconstruction (Feller et al., 2013). An understanding of how intrinsic factors influence RTS is important. Age and gender are not modifiable but can assist clinicians in planning the duration (associated costs) and structure of the rehabilitation programme. Knowing which, if any, modifiable intrinsic factors influence RTS will enable pro-active planning to ensure timely and safe return to sport.

Two published SR's broadly investigated variables associated with RTS (Ardern et al, 2014; Czappon, Racette, Klein & Harris-Hayes, 2014). Ardern et al (2014) aimed to update the RTS rate, with a secondary aim to investigate physical and contextual factors associated with RTS. Czappon et al (2014) appraised the risk of bias across studies of various designs and described variables associated with RTS. Both reviews included studies of considerable heterogeneity with respect to study design, evidence levels, samples and aims. None of these reviews appraised the evidence of only intrinsic

factors and due to their broad aims did not include all studies reporting on intrinsic factors related to return to sport.

The objective of our review is thus to systematically appraise *all* evidence for intrinsic factors exclusively and their association with RTS participation at the pre-injury level. RTS participation, at the pre-injury level, is considered an indicator of the success of ACL reconstruction for both competitive and recreational level athletes (Lee, Karim & Chang, 2008). This review will offer clinicians, patients, coaches and sports administrators, a succinct evidence synthesis of intrinsic factors related to RTS to facilitate evidence based management.

2.2 METHODOLOGY

This systematic review was composed according to guidelines by Sterk & Rabe (2004) using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA checklist, 2009). Ethical approval for this review was waived as no human or animal participants were involved. Cohort, case control and cross-sectional studies published as peer-reviewed journal publications in the English, French or German languages were considered. Publications that included male and/or female participants from 13 years of age, who participated in physical activity (recreational or competitive sport) at least twice a week before sustaining an ACL injury, were eligible. Studies reporting on participants who required surgery to reconstruct the ACL using all graft types (hamstring or patellar tendon autograft, or allograft), were considered. All studies had to report on return to the *same* sport, either at the same or a lower intensity level. Intrinsic factors included, but were not limited to, age, gender, quadriceps muscle strength, fear of re-injury, leg dominance, BMI and degree of ACL laxity pre-operatively.

2.2.1 Search strategy

The Stellenbosch University online library was used to search the following electronic databases: CINAHL, PubMed, Scopus, SPORTDiscus, Google Scholar and ScienceDirect. These specific databases are often used to search for literature pertaining to health related systematic reviews (Wright, Brand, Dunn & Spindler, 2007). All selected databases were searched from inception until July 2014. Two searches were performed. Anterior Cruciate Ligament was a stand alone key word used for all search strategies. In the first search, combinations of keywords including [post surgery] AND [outcomes] AND [predictors] AND [physiotherapy OR physical therapy] AND [return

to sport] were added to develop an appropriate search string. MeSH terms were used in PubMed. A second, more refined search was performed to find additional publications by composing a more precise search string. Here, the intrinsic factors [age] OR [dominance] OR [Muscle strength] OR [BMI] OR [body weight] OR [laxity] OR [gender] or [fear] OR [activity level] were added independently as key words to three databases, thus yielding the most relevant hits. Pearling of reference lists of included studies was performed.

2.2.2 Study selection

One reviewer screened the titles and abstracts of all initial hits. Two reviewers independently screened all potential full text papers, according to the eligibility criteria. To ensure consistency between reviewers, a checklist for eligibility was developed. This checklist contained all eligibility criteria as described. Discrepancies between reviewers regarding eligibility were discussed until consensus was reached.

2.2.3 Methodological quality appraisal

The methodological quality of each study was appraised by one reviewer using the Critical Appraisal Skills Program (CASP) for Cohort studies (Public Health Resource Unit, NHS, England). No randomised controlled trials met the inclusion criteria, therefore eliminating the use of the CONSORT statement, which is a validated tool. CASP has separate scales for specific study designs; this scale assesses cohort studies only and was therefore appropriate for this review. This tool can be used as either a checklist or a scoring system, thus was used as it facilitates simple and reliable scoring. The critical appraisal tool comprised of 12 criteria to which a “yes”, “no” or “can’t tell” response was

assigned and justified. Two of the criteria did not yield “yes”, “no” or “can’t tell” responses, thus they were rephrased. The original criteria, including “What are the results of the study?” and “How precise were the results?” were adapted as follows; “Are the results clearly described?” and “Have the probability values been reported?” All “Yes” responses were tallied and a score was assigned for each study. The best score was a total of 12 points. One randomly selected study was appraised by a second reviewer and discrepancies in scores were discussed.

2.2.4 Data extraction

Data extracted from each study was summarised using a customised Excel data extraction sheet. Information about the sample demographics, sample size, intrinsic factors (as defined in eligibility), type of sport, time from surgery to study assessment, level of sports participation, statistical procedures, findings and limitations of each study were extracted. The demographic variables included age and gender. A second reviewer extracted the data of two randomly selected studies, to ascertain the accuracy of data extraction.

2.2.5 Data analysis/synthesis

A meta-analysis was not possible due to the variations in study outcomes. There were also marked differences between statistical analysis procedures, intrinsic factors and the type of data reported. For this reason, a descriptive synthesis of the findings was conducted. Information was tabulated to compare the findings of eligible studies. Odds ratios and 95% confidence intervals were calculated by means of a 2x2 table calculator for the five studies investigating the association of gender with RTS (Arder, Taylor,

Feller & Webster, 2013; Arden et al., 2011; Kvist, Ek, Sporrstedt & Good, 2005; Lentz et al., 2012; Smith et al., 2004). This was repeated for the study by Osti et al (2011) investigating the association of age with RTS and two studies investigating knee function with RTS (Lee et al., 2008; Smith et al., 2004). A subgroup analysis of activity level with the associated intrinsic factors was performed, as the studies reviewed included a range of activity levels, from recreational to competitive.

2.3 RESULTS

Ten studies met the inclusion criteria (Appendix 1). The full search results are displayed in Figure 2. The studies were conducted in a range of countries with four in Europe, two in Asia, two in the USA/Canada and two in Australia.

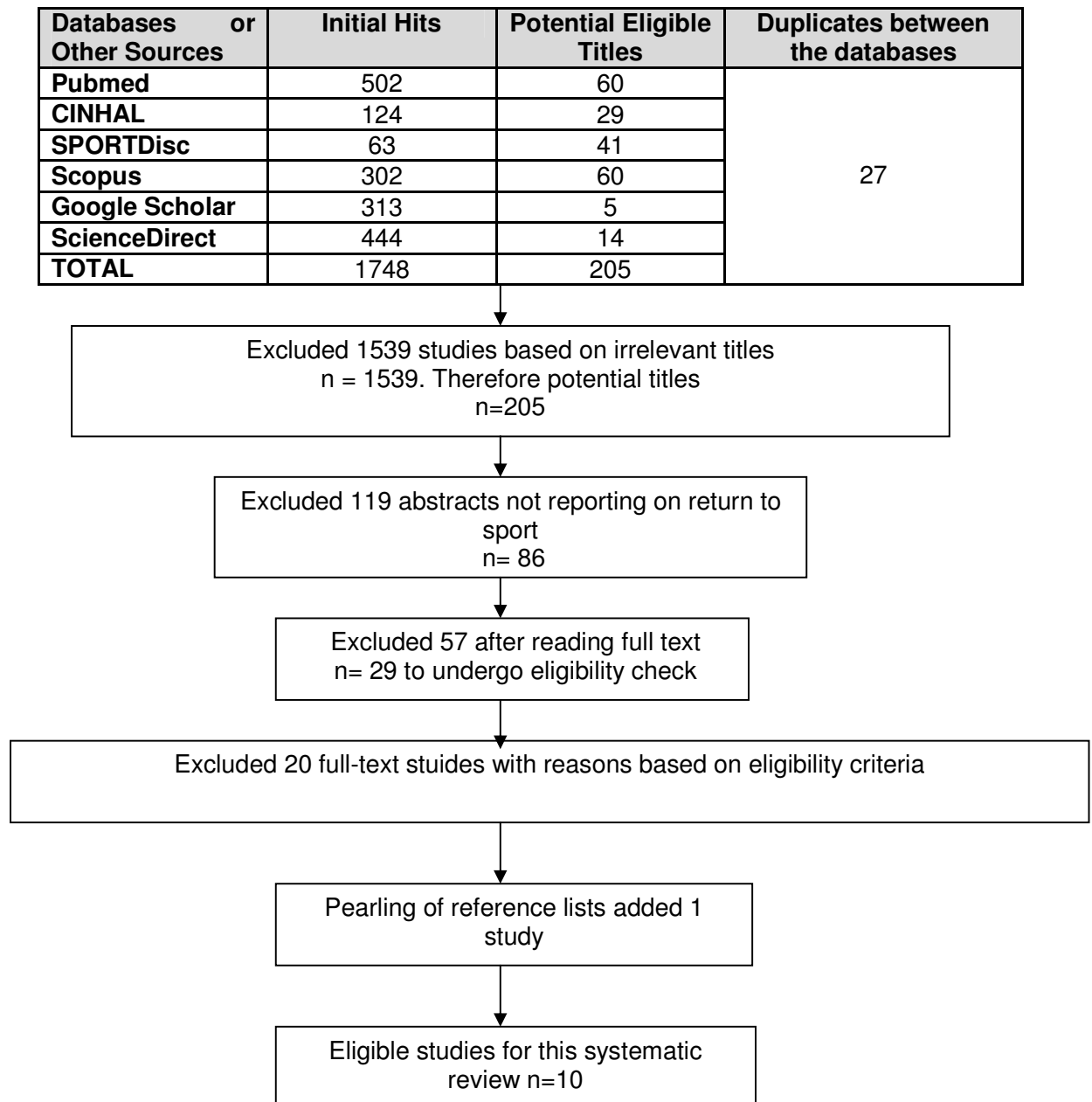


Figure 2: Results of search strategy

2.3.1 Critical appraisal of study quality

A median appraisal score of 10 (range 8-11) was obtained after critical appraisal of study quality. The findings of the methodological appraisal, with the reasons for the negative scoring per criterion, are described in Table 2.1.

Table 2.1 Findings of Critical Appraisal of Methodological Quality

Criterion	Arder n et al (2011)	Arder n et al (2013)	Devga n et al (2011)	Gobbi and Franci sco (2006)	Kvis t et al (200 5)	Le e et al (20 08)	Lent z et al (201 2)	Ost i et al (20 11)	Smit h et al (200 4)	Trip p et al (200 7)
1. Clear aim	+	+	+	+	+	+	+	+	+	+
2. Appropriate method	+	+	+	+	+	+	+	+	+	+
3. Acceptable sampling	+	+	+	+	+	+	+	^{-a}	+	+
4. Exposure accurately measured	+	+	+	+	+	+	+	+	+	^{-e}
5. Outcome accurately measured	+	+	^{-d}	+	+	+	+	+	+	+
6. Identification of confounding	+	+	^{-d}	^{-d}	+	+	+	+	+	+
7. Follow up sufficiently long and complete	^{-g}	^{-g}	+	^{-g}	^{-g}	^{-g}	^{-h}	+	+	^{-h}
8. Results clearly described	+	+	+	+	+	+	+	+	+	+

9. Reporting of probability values	+	+	+	+	+	+	+	+	+	+
10. Do you believe the results	+	+	+	+	+	+	+	^{b/c/f}	+	+
11. Results applicable to local population	^c	^c	+	+	+	+	^c	^{c/f}	^{c/f}	^c
12. Do the results fit with other evidence	+	+	+	+	+	+	+	^d	+	+
Score	10	10	10	10	11	11	10	8	11	9

Reasons for negative score:

^a Sample bias or not described, ^b Confounding factors not taken into account, ^c Selection bias, ^d not reported, ^e patient not blinded/masked to purpose of study, thus intrinsic factor, ^f small sample size, ^g loss to follow-up, ^h no longitudinal follow up

2.3.2 Study sample description

Of the studies reviewed, four had a similar number of male and female participants and six had approximately twice as many male participants (Table 2.2). Age ranged from 14 to 62 years, with an average age of 26.2 years in all the studies except the study by Osti et al (2011) that looked at separate age groups. The competitive level, sample size, time from surgery to follow-up in each study, including the RTS participation at both pre-injury and lower activity level, is presented in Table 2.2. Competitive level athletes include athletes competing at a national or provisional level. Studies on competitive level athletes showed a tendency to have a lower RTS rate. Time from injury to follow-up varied from twelve months (by which time athletes following any protocol are permitted to return to competitive or pivoting sports) to five years (illustrating the sustainability of the reconstruction). The rate of RTS did not favour an early or later follow-up time period. Athletes participated mainly in the following sports: soccer (Ardern et al., 2011;

Ardern et al., 2013; Osti et al., 2011; Tripp, Stanish, Ebel-Lam & Brewer, 2007); basketball (Ardern et al., 2011; Ardern et al., 2013; Osti et al., 2011; Tripp et al., 2007); skiing (Osti et al., 2011; Tripp et al., 2007); hockey (Osti et al., 2011); motocross (Tripp et al., 2007); netball (Ardern et al., 2011; Ardern et al., 2013); athletics, martial arts and cricket (Devgan et al., 2011) .

Table 2.2 Sample description for each study included in the SR

	% returned to the same sport and activity level	% returned to modified sport or activity level	Activity level	Sample size	Time from surgery to follow up
Ardern et al (2011)	33%	33%	Competitive	503	1 year
Ardern et al (2013)	31%	Not reported	71% Competitive, 29% Recreational	178	1 year
Devgan et al (2011)	46%	37.5%	Competitive – district, state and national	48	5 years
Gobbi and Francisco (2006)	65%	24%	All levels	100	3, 6, 12 and 24 months
Kvist et al (2005)	53%	45%	All levels. 67% contact sport	62	3-4 years
Lee et al (2008)	62%	Not reported	67% recreation participation twice a week, 33% competitive including 2 national	64	5 years
Lentz et al (2011)	55%	36%	All levels	94	1 year
Osti et al (2009)	60% and 90%	35% and 5%	All levels and type of sports	40	2 years
Smith et al (2004)	42%	19%	Competitive - elite	77	43 months
Tripp et al (2007)	<i>M = 7.3 out of 10, SD = 2.7</i> higher values=better RTS rate		Recreational	49	1 year

2.3.3 Study design, aims and outcomes

The studies included were cohort studies, prospectively following up athletes who underwent an ACL reconstruction. These studies included subjects with associated cartilage damage or meniscus repair, but excluded subjects if multiple ligament reconstruction or revision took place. All studies aimed to determine the factors associated with return or non-return to pre-injury activity level with a follow-up time of between twelve months and five years. Factors including gender, age, muscle strength, knee ligament laxity, fear of re-injury, and knee function were described among the studies. There were no studies associating BMI and leg dominance with RTS post ACL reconstruction.

2.3.4 The association of fear of re-injury with RTS

Tripp et al (2007) analysed whether fear of re-injury, negative affect (mood) or catastrophisation predicted RTS. They found that a high level of fear of re-injury was a significant predictor of not returning to sport ($p=0.01$). Similarly, Ardern et al (2013) investigated whether psychological responses pre-operatively and at four months post-operatively predicted RTS at 12 months. The findings indicated that psychological responses predicted RTS pre-operatively ($p<0.001$). However, the optimal prediction of RTS was at four months measured by the Anterior Cruciate Ligament-return to sport after injury scale (ACL-RSI), with the Tampa Scale of Kinesiophobia (TSK) and Sport Rehabilitation Locus of Control scale (SRLC) also predictive in the reduced model ($p<0.001$). Unfortunately, the percentage of athletes who returned to sport and those not returning due to fear of re-injury was not mentioned and thus prevented comparison between these two studies and others describing fear of re-injury.

Kvist et al (2005) used the TSK to quantify fear of re-injury. Participants who did not return to sport scored higher on the TSK, indicating more fear of re-injury ($p=0.01$). In addition to Kvist et al (2005), four other studies (Devgan et al., 2011; Gobbi & Francisco, 2006; Lee et al., 2008; Lentz et al., 2012) also investigated fear of re-injury in relation to RTS. Across these studies, the 141 athletes not returning to pre-injury sport were questioned as to the reason for non return. An average of 35% (49 athletes) cited fear of re-injury as the reason. The percentages of athletes citing fear of re-injury in each study are displayed in Table 2.3.

Table 2.3 Number of athletes citing fear as the reason for not returning to their previous level of sport

	Total assessed for return to sports	Athletes not returning to previous level of sport	Athletes citing fear as the reason for non return (%)*
Devgan et al (2011) ^a	40	18	12 (67%)
Gobbi & Francisco (2006) ^b	100	35	2 (6%)
Kvist et al (2006) ^b	62	29	7 (24%)
Lee et al (2008) ^b	45	17	9 (53%)
Lentz et al (2011) ^b	94	42	19 (45%)
Total	341	141	49 (35%)

^a Competitive level athletes

^b Competitive and recreational athletes combined

*Percentage of athletes not returning to previous level of sport due to fear of re-injury out of those not returning to sport

2.3.5 The association of age with RTS

The association of age with RTS was the objective of the study by Osti et al (2011) who separated participants into two distinct age groups (younger than 30 years and older than 50 years of age) with twenty athletes in each group. The RTS at the pre-injury activity level was compared. A significant difference was found; 90% of athletes returned to sport in the under 30 age group, compared to a 60% return in the over 50 age group. The level of sporting activity differed between age groups; older participants had a lower level of sporting activity pre-operatively, which was considered on RTS. The findings indicated that younger athletes are more likely to return to the pre-injury level of sport (Odds ratio = 6, $CI= 1.08-33.28$). Two studies (Ardern et al., 2013; Lentz et al., 2012) compared the mean age of the non-return group to those returning to pre-injury level of sport and found no significant difference ($p=0.066$ and $p=0.6$ respectively). However, the samples were not separated into two age groups; therefore comparison to the aforementioned study could not be made.

2.3.6 The association of gender with RTS

Five studies (Ardern et al., 2011; Ardern et al., 2013; Kvist et al., 2005; Lentz et al., 2011; Smith et al., 2004) examined the association of gender with RTS at the pre-injury activity level. The odds ratios were calculated to indicate whether gender is associated with RTS. The results are displayed in Table 2.4.

Table 2.4 Association of gender with RTS

	Study sample	Odds Ratio	95% Confidence intervals (CI)	Significant association
Ardern et al (2011) ^a	340 male and 163 female	1.70	1.12-2.57	Males significantly more likely to return to sport
Ardern et al (2013) ^b	122 male and 56 female	1.34	0.71-2.73	No significant difference (CI not significant)
Kvist et al (2005) ^b	34 male and 28 female	0.75	0.27-2.05	No significant difference
Lentz et al (2011) ^b	60 male and 34 female	0.97	0.41-2.25	No significant difference
Smith et al (2004) ^a	37 male and 40 female	1.50	0.55-4.08	No significant difference (CI not significant)

^a Competitive level athletes only^b Competitive and recreational athletes combined

2.3.7 The association of post-operative knee function/integrity with RTS

Nine of the eligible studies reported on knee function, assessed in the time-frame stated in Table 2.2 (Ardern et al., 2013; Ardern et al., 2011; Devgan et al., 2011; Kvist et al., 2005; Lee et al., 2004; Lentz et al., 2012; Osti et al., 2011; Smith et al., 2004; Tripp et al., 2007). Table 2.5 displays the measurement tool used in each study, the results thereof and whether or not the outcome measure was found to be associated with RTS. This is important as these outcome measurement tools are frequently used to assess an athletes' readiness for RTS. However, if they are not predictive of RTS, athletes with good knee function scores may not RTS for other reasons. Lentz et al (2012) questioned the athletes as to the number of episodes of giving way or buckling of the knee since the

surgery. They found significantly fewer episodes described by those returning to the pre-injury sport than not returning ($p=0.044$). Quadriceps strength testing was also performed in this study. Results show that the quadriceps symmetry index was not significantly associated with RTS ($p=0.150$), however the knee extensor torque normalised to body weight ratio did show a significant association ($p=0.050$).

Table 2.5 Association of self reported knee function/integrity with RTS

Author	Knee outcome measure	Reported findings	Knee function associated with RTS
Ardern et al (2011)^a	IKDC: (excellent compared to poor score) IKDC (excellent compared to good score)	Risk ratio, 1.5; 95% CI, 0.86-2.50 Risk ratio, 1.05; 95% CI, 0.81-1.40	No
Ardern et al (2013)^b	Subjective IKDC Objective IKDC	Subjective IKDC associated with RTS $p=0.03$ Objective IKDC associated with RTS $p=0.20$	Yes No
Devgan et al (2011)^a	Subjective and Objective IKDC/ Lysholm scales	Objective IKDC associated with RTS $p=0.004$ Subjective IKDC associated with RTS $p<0.0001$ Lysholm score associated with RTS $p<0.0001$	Yes
Gobbi and Francisco (2006)^b	Subjective and Objective IKDC, Noyes, Lysholm and Tegner	Subjective IKDC ($p=0.22$) Objective IKDC ($p=0.38$); Noyes ($p=0.053$); Lysholm ($p=0.38$); Tegner ($p=0.94$)	No

	Marx activity scale	Athletes who returned to sport scored significantly higher than those who did not return ($p<0.001$)	Yes
Kvist et al (2005)^b	Questionnaire KOOS	KOOS negatively correlated with TSK ($r=-0.434$, $p.05$) and RTS correlated negatively with TSK ($p=0.01$). It is therefore likely that KOOS will correlate with RTS	Likely
Lee et al (2012)^b	Lysholm score/IKDC	IKDC Odds ratio, 0.22; 95% CI, 0.45-1.04	Yes
Lentz et al (2012)^b	Tegner scale, IKDC	Tegner ($p<0.001$) IKDC ($p<0.001$)	Yes
Osti et al (2011)^b	IKDC	Participants who did not return to sport had more associated injuries i.e. meniscus injuries	Yes
Smith et al (2004)^a	Questionnaire	Odd ratio, 3.4; 95% CI, 1.09-10.73	Yes

^a = Competitive level athletes^b = Athletes of all activity levels

IKDC= International Knee Documentation Committee

KOOS = Knee Injury and Osteoarthritis Outcome Score

2.3.8 Subgroup analysis of activity level with factors associated with RTS

This review considered heterogeneous studies, describing different levels of sports participation, including competitive level athletes (n=3), all levels (n=6) and recreational athletes (n=1). A subgroup analysis was done to identify factors showing a strong association with return to pre-injury level of sports participation in each subgroup. The results of the subgroup analysis are displayed in Table 2.6.

Table 2.6 Subgroup analysis of activity level and factors showing strong association with RTS

Competitive athletes	Recreational athletes	All levels of activity
Male gender (Arderon et al., 2011; Smith et al., 2004)	Less fear of re-injury (Tripp et al., 2007)	Younger age (Osti et al., 2011)
Less fear of re-injury (Devgan et al., 2011)		Less fear of re-injury (Arderon et al., 2013; Kvist et al., 2005; Lee et al., 2008; Lentz et al., 2011)
IKDC (Devgan et al., 2011) Lysholm (Devgan et al., 2011)		Marx activity scale (Gobbi & Francisco, 2006) IKDC (Lee et al., 2008; Lentz et al., 2011) Tegner (Lentz et al., 2011)

2.4 DISCUSSION

This systematic review highlights modifiable and non-modifiable intrinsic factors associated with RTS participation (at the same pre-injury activity level). We found that fear of re-injury is a common reason for athletes not returning to sports (Devgan et al., 2011; Gobbi & Francisco, 2006; Kvist et al., 2005; Lee et al., 2008; Lentz et al., 2012; Tripp et al., 2007) at all levels of participation. In three studies (Devgan et al., 2011; Lee et al., 2008; Lentz et al., 2012) approximately half the athletes who did not return to sport cited fear as the reason for non-return.

Fear of re-injury is a potentially modifiable factor. Physical problems such as impaired neuromotor control, poor proprioception, or knee instability may be associated with fear of re-injury. Larmer, McNair, Smythe & Williams (2011) found a reduction in fear of re-injury in participants post ankle ligament injury, after they practiced performing the feared exercise. Following the ligament reconstruction and completion of the rehabilitation programme, it is assumed that the athlete may be confident to RTS. However, our review findings illustrate that this assumption may not be true. It is thus important to increase awareness of the association between fear of re-injury and RTS among clinicians. Early identification and interventions aimed at reducing fear may be useful. Physical rehabilitation could be complimented with education and improving self-efficacy in an attempt to reduce fear of re-injury (Soderlund, 2011).

Fear of re-injury may differ in recreational and competitive athletes. Re-injury or a long rehabilitation period negatively affects the competitive athlete, possibly diminishing the chances of returning to their position (Kvist et al., 2005). To reduce fear of re-injury, the length of time invested in rehabilitation should be optimised by motivating athletes to be

compliant with their sport specific exercises (Devgan et al., 2011). Another suggestion by Tripp et al (2007) is that fear of re-injury or movement is a form of avoidance behaviour evident in people with pain, which may further impair the neuromusculoskeletal system. Therefore, pain at the time of injury and surgery, should be well managed to minimise this psychological component (Kvist et al., 2005). Ardern et al (2013) indicated that psychological factors measured at four months post-operatively predicted RTS better than those measured pre-operatively. This indicates a temporal progression of fear of re-injury. It is unknown whether the fears exist pre-operatively or whether it develops through the rehabilitation process. These issues require further research. Psychological screening of the athlete prior to RTS may be as valuable as physical measures of readiness (Ardern et al., 2013). The re-injury anxiety inventory is an instrument which has been suggested by Walker, Thatcher & Lavalley (2010). This also affirms that RTS needs an inter-professional approach.

The studies pertaining to fear of re-injury had methodological shortcomings. Firstly, males were predominantly included and generalisation to females is limited (Devgan et al., 2011; Gobbi & Francisco, 2006; Lee et al., 2008; Lentz et al., 2012). In three of the studies (Devgan et al., 2011; Gobbi & Francisco, 2006; Kvist et al., 2005), questions regarding fear of re-injury were not directed to the entire sample which may further compromise the generalisability of the study findings. In one study (Lentz et al., 2012), fear of re-injury was the most commonly cited reason for non RTS however in a multivariate analysis, the association was insignificant. Therefore, further research is required before conclusive findings can be drawn about the association.

We found only one study which investigated whether age is related to RTS (Osti et al., 2011). The findings of this single study showed that younger athletes are more likely to

RTS. However, the power of this study was limited by the small sample size. Older athletes generally participate at a lower level than younger athletes; therefore a subgroup analysis of activity level could not be performed. Younger athletes have more educational and occupational commitments; therefore this subgroup was excluded in the study by Lentz et al (2012) who reported no association between age and RTS. Younger athletes may require shorter rehabilitation periods as they possibly have better coping strategies and reduced fear of re-injury. When assessing RTS, a longer follow-up time may be required for older athletes (Soderlund, 2011). Older athletes may also be less likely to RTS due to poorer knee function, muscle atrophy and proprioception deficits. Additionally, pre-existing pathological conditions may be more prevalent with advancing age (Osti et al., 2011), complicating the post-surgical recovery. Thus, it may be advisable for athletes to undergo ACL surgery as early as possible, if required. While this systematic review only considered adolescents from the age of thirteen, a review by Vavken & Murray (2011) on ACL reconstruction in skeletally immature patients, revealed good results of surgical treatment with minimal risk of growth disturbance. Therefore, a better RTS rate after ACL reconstruction is expected in younger athletes.

The findings regarding gender were inconsistent (Ardern et al., 2011; Ardern et al., 2013; Lentz et al., 2012; Smith et al., 2004; Tripp et al., 2007). In one study, with a large sample size, male athletes were significantly more likely to RTS than females (Ardern et al., 2011). Due to improved power and smaller sampling error, the findings of this study by Ardern et al (2011) is arguably more valid and generalisable, compared to the smaller studies. Thomee et al (2007) indicated that post ACL reconstruction; males had a significantly higher self-efficacy, which can be described as the personal belief of ones capability to perform difficult tasks (Soderlund, 2011). A higher self-efficacy will be more advantageous in the competitive subgroup, where from our conclusions; males appear

to be more likely to RTS. Psychological factors, such as fear and motivation may be different between males and females and should be considered during rehabilitation. This association of gender with RTS warrants further research before valid conclusions can be made.

The intuitive assumption that good knee function relates to a better RTS rate may not always be true. Our findings suggest that good knee function is not always associated with a higher likelihood to RTS (Ardern et al., 2011; Smith et al., 2004). However, the same scale for knee function was not used in all the reviewed studies, thereby limiting comparison between studies (Ardern et al., 2011; Devgan et al., 2011; Gobbi & Francisco, 2006; Lee et al., 2008; Lentz et al., 2012). The reliability of the measurement tools (Devgan et al., 2011; Kvist et al., 2005; Lee et al., 2008; Lentz et al., 2012; Tripp et al., 2007), execution of tests (Ardern et al., 2011; Gobbi & Francisco, 2006; Lentz et al., 2012; Osti et al., 2011; Smith et al., 2004) and content of subjective questionnaires (Ardern et al., 2011; Devgan et al., 2011; Gobbi & Francisco, 2006; Kvist et al., 2005; Lentz et al., 2012; Smith et al., 2004) were stated in all studies. The Marx activity scale is positively associated with RTS however, due to a large loss to follow-up; bias may have influenced the findings. Narducci et al (2011) investigated the clinical utility of functional performance tests one year post ACL reconstruction in a systematic review and did not find a test with construct or predictive validity for RTS. This may be a useful area for future research.

Our review included studies on physically active participants only. This implies that findings potentially cannot be generalised to other subgroups, such as physically inactive individuals or children. In this review, competitive athletes showed a generally lower RTS rate, when compared to studies including athletes competing at all levels. In contrast,

two studies (Devgan et al., 2011; Lee et al., 2008) reported a higher RTS rate among competitive athletes. Different motivational factors exist between competitive and recreational athletes. Competitive sport is more demanding and therefore may result in a lower rate of return (Smith et al., 2004). Tripp et al (2007) studied recreational athletes and suggested that if fitness was their main concern, they might change to another sport of similar intensity, less threatening to the ACL. Focussing on one subgroup of athletes only, prevents overestimating the RTS rate (Ardern et al., 2011), thus findings may be more reliable, albeit less generalisable.

Follow-up times of studies varied, from between 1 year and 5 years across the studies, with a large loss to follow-up evident in the studies assessing athletes at 5 years post reconstruction (Kvist et al., 2005; Lee et al., 2008). One study (Smith et al., 2004) assessed the RTS status at 12 months, then again at a later stage. They found that RTS rate decreased over time. However, the limited number of studies prevented sensitivity analysis for different follow-up time frames.

The evidence base is currently small and excluded BMI and leg dominance with a paucity of evidence regarding laxity and quadriceps muscle strength (Lentz et al., 2011), thus recommended for future research. Lentz et al (2011) found quadriceps peak torque to body weight ratio significantly associated with RTS, in contrast to other literature reporting inconsistent results of quadriceps strength on functional outcomes (Ross, Irragang, Denegar, McCloy & Unangst, 2002). Kvist et al (2005) found no correlation between age and the TSK. However, many other factors may be associated with fear (Tripp et al., 2007) including proprioception or neuromuscular control (Smith et al., 2004), pain (Kvist et al., 2005; Tripp et al., 2007), gender and time from injury to surgery (Lee et al., 2008), which could be considered in future studies.

This review includes studies assessing intrinsic factors at the time of follow up when athletes are cleared for RTS, therefore demonstrating their association, but it cannot be assumed that the same factors will be predictive of RTS if assessed prior to the athletes' RTS. The review has a number of limitations. One limitation related to the small evidence base, which is limited to ten studies. Furthermore a meta-analysis was not possible due to heterogeneity between studies. Our review could have been subjected to selection bias as titles were screened by one reviewer. In addition, we only considered three languages and language bias could have influenced the review findings. The strengths of the review include the sound methodological screening of studies to ensure that only high quality studies were eligible. Furthermore the focus of the research question was specific to intrinsic factors.

2.5 CONCLUSION

The systematic review focused on intrinsic factors which may be associated with RTS after ACL reconstruction. The findings show that fear of re-injury is a common reason for not returning to sports participation. Younger athletes may be more likely to RTS, but findings regarding gender were equivocal, with male competitive athletes appearing more likely to return. Good knee function is not always associated with a higher likelihood to return to sport. Fear of re-injury and age should be considered in the management of sports participants post ACL reconstruction. Due to the small, heterogeneous evidence base, further research is required.

CHAPTER 3

Factors Informing Fear of Re-Injury after Anterior Cruciate Ligament Reconstruction

3.1 INTRODUCTION

The anterior cruciate ligament (ACL) is one of the most common and devastating sports injuries (Ardern et al., 2011). ACL injury results in loss of knee stability which may impair return to sport (RTS) affecting athletes socially and psychologically (Grindem et al., 2012). Surgical reconstruction of the ACL is often performed to prevent complications and facilitate RTS (Smith et al., 2004). By 12 months post surgery RTS can be expected, however only two thirds of athletes achieve this (Ardern et al., 2011). RTS after ACL reconstruction thus remains challenging.

Reasons for sport cessation post ACL reconstruction are insufficiently described. Devgan et al., (2011) found that seventeen percent of athletes terminate sports participation for personal reasons such as marriage, education, finance and change in social circle. Ongoing knee pain and functional problems including instability, stiffness, weakness and poor proprioception may be associated with non-return (Smith et al., 2004). However, some athletes do not return to sport despite high knee function scores (Lentz, Karim & Chang, 2008). Scales to measure psychological readiness to RTS, particularly the adapted TSK and the ACL-RSI have been implemented in studies and show that fear of re-injury is a popular reason for non-return (Langford, Webster & Feller, 2009).

Fear of movement is described as a form of avoidance behaviour and is well documented in chronic low back pain (Crombez, Vlaeyen, Heuts & Lysens, 1999). This type of avoidance behaviour may also manifest post ACL surgery as fear of re-injury (Tripp et al., 2007). The term “fear of re-injury” is commonly used in literature describing cessation of sport after ACL reconstruction and is thus used in this study for consistency (Kvist, Ek, Sporrstedt & Good, 2005; Tripp et al., 2007; Ardern et al., 2011) however, Walker, Thatcher & Lavalley (2010) suggests that “re-injury anxiety” is a more appropriate term as fear is a biological mechanism, whereas anxiety results from previous experience.

Restriction of sporting activity due to fear of re-injury is commonly discussed between the patient and clinician, emphasising concern about fear of re-injury (Barton, Grana, Indelicato, O'Neill & George, 2007). Returning to the pre-injury sport or physical activity is an important post-operative goal and currently a very topical research area (Ardern et al., 2014; Czuppon et al., 2014). Fear of re-injury may also be associated with poor compliance with rehabilitation (Heijne, Axelsson, Werner & Biguet, 2008; Pizzari, McBurney, Taylor & Feller, 2002). Therefore, fear compounded by inadequate rehabilitation will further reduce the likelihood of RTS.

To our knowledge, there is no published research specifically exploring what factors inform fear of re-injury post ACL reconstruction. Poor knee function results in a physical sensation in the affected knee which becomes the focus of the athlete and either diminishes performance or informs fear of re-injury (Walker et al., 2010). In this study,

participants citing poor knee function in addition to fear of re-injury were excluded in order to explore the non-physical contribution to fear of re-injury. The aim of our study is to describe what informs athletes' experience of fear of re-injury post ACL reconstruction in athletes who cited fear as the sole reason for not returning to the pre-injury level of sport. The results from this study could be incorporated in post-operative management.

3.2 METHODOLOGY

3.2.1 Ethical considerations

The protocol for this study was approved by the Health Research Ethics Committee of Stellenbosch University, South Africa, and conducted according to the ethical guidelines and principles of the International Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research. Ethics Reference #: S14/02/032

3.2.2 Study design

This study consists of a mixed methods study design of qualitative and supplemental quantitative analysis. A descriptive qualitative study was conducted by inductive content analysis. Semi-structured interviews were used to obtain information about the participants' experiences which inform or fear of re-injury. Their post operative management was also discussed with the opportunity for suggestions given. The supplemental quantitative analysis was done to describe the association of particular variables with RTS, therefore allowing this study to be compared to other literature describing similar variables. The results of the qualitative analysis may therefore be generalisable to these populations and the external validity of the study is improved (Miles & Huberman 1994). The manuscript was composed according to Qualitative review guidelines – RATS.

3.2.3 Study setting

The study was conducted in Johannesburg recruiting participants who underwent ACL surgery at a conveniently selected private hospital by two orthopaedic surgeons specialising in the knee joint. Although all participants underwent surgery in the same hospital by one of the two surgeons using the same procedure, their post-operative rehabilitation (physiotherapy and biokinetics) took place at a practices which were conveniently located to the participants' residence. The same physiotherapist and biokineticist did not follow up all the participants; however the same rehabilitation protocol was followed as suggested by the orthopaedic surgeons concerned.

3.2.4 Sampling

Inclusion criteria for the study included male and/or female patients from 13 years of age (adults and adolescents), who participated in physical activity (recreational or competitive sport) at least twice a week before sustaining an ACL injury. Patients, who underwent surgery to reconstruct the ACL using any graft types (hamstring or patellar tendon autograft or allograft) with or without cartilage damage or meniscus repair, were considered. Theatre lists were screened for patients who had an ACL reconstruction between 1 June 2011 and 1 April 2013 (time from surgery to follow up of 12-38 months). Data collection stopped at 1 June 2011 as a sufficiently large sample of over 100 potential participants was obtained. After further exclusions, due to the patient residing outside of South Africa or having multiple ligament reconstruction or a subsequent revision operation, a total of 115 patients was identified and the respective files retrieved. Those who did not receive outpatient rehabilitation by the principal investigator were included. One hundred patients were potentially eligible who were proficient in

either the English or Afrikaans language. Details of these potential participants were accessed and the names replaced with numbers to ensure anonymity. The electronic survey sent out to this sample allowed identification of eligible participants for the qualitative study.

3.2.5 Research procedures

The procedure included the following two steps:

- Electronic survey of all 100 potential participants to identify those who did not return to the pre-injury level of sport due to fear of re-injury.
- Semi-structured interviews with eligible participants identified by the electronic survey.

i. Electronic survey

An electronic questionnaire (Appendix 3) was developed by the research team to ascertain the reason(s) for not returning to the pre-injury type and level of sport. The reasons were generated from our SR (Ross et al., 2015) and two published SR's (Ardern et al, 2014; Czuppon et al., 2014). The draft questionnaire was piloted among three patients who had an ACL reconstruction to determine the clarity of the questions and two minor changes were made.

The question regarding reasons for not returning to sport provided four answer options; knee function, fear of re-injury, social reasons, and an option of "other" where the opportunity to state the reason was given. More than one reason could be selected and further questions about fear of reinjury were avoided to minimise bias. An email was sent

to 90 of the potentially eligible participants for whom email addresses were obtained. The body of the email included the aim and objectives of the study, with the information leaflet and informed consent attached. The questionnaire was composed using SurveyMonkey which is a web survey development cloud based company providing free customised surveys. The following link to the online questionnaire was included in the email: <https://www.surveymonkey.com/s/THT58QZ>.

ii. Semi-structured interviews

All the participants (n=12) who responded to the survey and identified fear of re-injury as the stand alone reason for not returning to their pre-injury sport at the same level were interviewed. An interview schedule (Appendix 4) aligned with the aim of the study was composed by the research team. Factors informing their fear of re-injury were to be ascertained with guiding questions to maintain focus and consistency across the interviews, thus improving the reliability of the study (Miles & Huberman 1994).

The interview allowed confirmation of the type of sport and the level at which they participated both before and after the injury. Thus a Tegner activity score (Appendix 5) could be calculated. Thereafter, factors informing fear of re-injury were explored by open-ended questions. Expectations for RTS post surgery were also explored. Information about the post surgical rehabilitation process was obtained and the participants had the opportunity to make any comments or suggestions about strategies to improve their outcome. The interview was conducted in the English language (the first language of all participants) at a time convenient for the participant. The interviews were recorded using the TapeACall PRO app for iPhone, and numbered according to the

participant number to preserve anonymity. Additional field notes were taken during the interview. The audio transcripts were downloaded and password protected.

3.2.6 Data analysis

i. Quantitative analysis

Data extracted from the patient files included age, gender, contact details, type of sport, date of injury, and date of surgery. Data extracted from each file was summarised using a customised Excel data extraction sheet. The sample was described using means and standard deviations as appropriate for cross sectional studies. Risk ratios and 95% confidence intervals were calculated by means of a 2x2 table calculator to investigate the association of age, gender and time from injury to surgery, with return to the same sport played at the same level.

ii. Qualitative analysis

Athletes' experiences which informed fear of re-injury as described in the interviews was qualitatively analysed according to Pope, Ziebland & Mays (2006). An inductive approach was used. The audiotapes were transcribed verbatim with comparison to additional field notes for data validation purposes. Content analysis was undertaken by the first author by hand coding of important data related to the research question. In this study, a code was allocated to a participants' experience which informed their fear of re-injury after ACL reconstruction. Identification of emerging categories was performed by grouping of related codes. Relationships between the categories were synthesised into themes, thereby allowing interpretation of the raw data and developing a comprehensive

theory. Analyses (codes and themes) were cross-checked and compared with co-authors for internal consistency. Discrepancies between co-authors were discussed until consensus was reached. A qualitative researcher was consulted when deemed necessary. Exemplar quotations relating to these were included.

3.3 RESULTS

3.3.1 Outline of findings

Fifty-three (90%) participants sustained the ACL injury during their main sport. This is the sport to which RTS is concerned. An outline of the study findings with the recruitment strategy for qualitative interview eligibility is displayed in Figure 3.

3.3.2 Supplemental analysis

The supplemental quantitative analysis of the electronic interview findings to determine the association of gender, age and time from injury to surgery with RTS is displayed in Table 3.1.

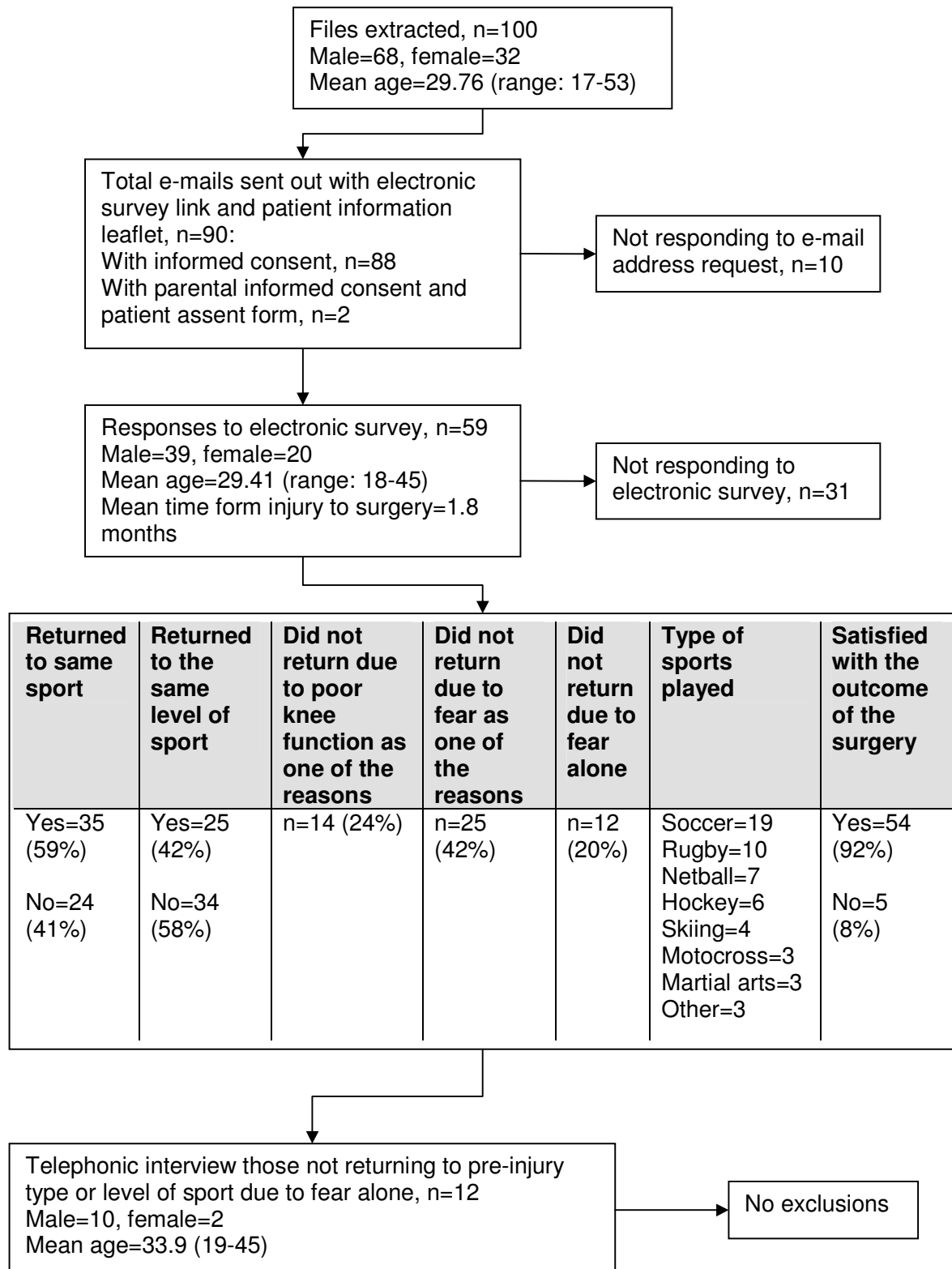


Figure 3: Recruitment strategy for qualitative interview eligibility

Table 3.1 Summary of results of electronic survey responses (n=59)

	Risk ratio (RR); 95% Confidence interval (CI)	Significance
Gender	^a RR=1; 95% ^b CI, 0.4-3.2	No significant difference between male and female ^c RTS rate
Age	RR=1.6; 95% CI, 1.1-2.3	* Younger than 20 years of age significantly more likely to RTS
	RR=1.4; 95% CI, 0.9-2.3	Younger than 30 years of age not more likely to RTS (CI insignificant)
	RR=1.2; 95% CI, 0.6-2.4	No significant difference between younger than 40 and older than 40 years of age in RTS rate
Time from injury to surgery	RR=1.1; 95% CI, 0.7-1.8	Time from injury to surgery less than 2 months not more likely to RTS (CI insignificant)
	RR=1.8; 95% CI, 0.8-4.0	Time from injury to surgery less than 6 months not more likely to RTS (CI insignificant)
	RR=1.4; 95% CI, 0.7-2.8	Time from injury to surgery less than 12 months not more likely to RTS (CI insignificant)

* = significant finding, ^aRR= Risk Ratio, ^bCI = Confidence Interval, ^cRTS = Return to sport

3.3.3 Participant-derived themes

Interviews with participants lasted between five and eleven minutes. From the interviews, 26 codes, 12 categories and four themes (Table 3.3) emerged which are described with quotations from the participants. The participant number appears in parenthesis. Demographic characteristics of the participants interviewed are displayed in Table 3.2.

Table 3.2 Demographic characteristics of participants interviewed (n=12)

Participant #	Age	Gender	Months from injury to surgery	Sport played pre-injury	Tegner activity score pre-injury	Tegner activity score at follow up
6	40	F	12	Skiing	6	5
8	31	M	9	Netball	7	5
32	45	M	1	Motocross	7	5
36	19	M	12	Rugby	9	7
40	30	M	1	Rugby	9	8
44	45	M	1	Soccer	7	5
54	31	M	1	Kickboxing	10	5
66	25	M	12	Rugby	9	7
68	32	M	2	Soccer	7	4
85	40	M	12	Motocross	7	5
90	38	F	unreported	Hockey	8	5
98	31	M	1	rugby	9	5
Mean	33.9		5.8		7.9	5.5

Table 3.3 Themes, categories and codes

Themes	Categories	Codes
1. Undergoing the surgery and recovery process again	1. Long recovery	1. (n=6)
	2. Inconvenience	2. (n=5)
	3. Pain at time of surgery	3. (n=3)
2. Nature of the sport imposed an increased risk of re-injury	4. High intensity nature of sport or direct impact	4. (n=8)
	5. At competitive level	5. Has sustained other injuries (n=1) 6. Has sustained a subsequent injury (n=1)
	6. Frequently performed movement caused the injury	7. (n=3) 8. Unusual injury (n=1)
3. Personality/Psychological	7. Personality	9. Determined (n=1) 10. Lacks confidence (n=1) 11. Cautious (n=1) 12. Worried about the future (n=2) 13. Pessimistic (n=1)
	8. Pain related to injury	14. Warning pre-injury (n=1) 15. On injury (n=2)
	9. Psychological	16. (n=6)
4. Social Priorities	10. Commitments	17. Studies (n=1) 18. Busy personal life (n=1) 19. Married (n=1) 20. Financial (n=2) 21. Children (n=1) 22. New sport (n=1)
	11. Advancing age	23. (n=4)
	12. Pressures from others	24. Friends (n=1) 25. Spouse (n=1) 26. Social life affected (n=2)

i. Undergoing surgery and the recovery process again

The majority of participants interviewed described experiences within this theme (n=9 male). These participants complained of either pain at the time of surgery, the lengthy rehabilitation and/or the inconvenience of restricted functional ability. The latter two aspects appeared to be unexpected.

“Having the op would not have been an issue if the recovery was quick. But a 12 month recovery period is what has probably curbed me a bit” (32).

Similarly, three participants in professional careers found the inconvenience of time away from work for at least two weeks, in addition to crutch walking and restricted driving ability for between two and six weeks outweighed the pain and prolonged the post-operative recovery:

“I found that the surgery was relatively pain free. But it was the inconvenience afterwards. Going for physio, the rehab, and walking around on crutches” (44).

For one participant, the pain was off-putting:

“To go through that pain again for the first 2 weeks after surgery is just not worth it” (68).

Two participants found time away from sport during recovery a hindrance. They have been able to resume sport, albeit different and less threatening to the knee, and are content to avoid risk of further injury and prolonged time off the field in the future. Another participant complained that the entire process was painful, lengthy and inconvenient, thus terminating sport for fear of undergoing this again due to re-injury (98).

ii. The nature of the sport imposed an increased risk of re-injury

Eight participants attributed their fear of re-injury to the nature of the sport in which they were competing prior to injury. The risk of re-injury was perceived as too high:

“You are always in that situation [motocross] so I think there is more likelihood of that type of injury” (32); “The chances of the injury repeating in the same knee or in the other knee are too high, so I am not even interested” (98).

These sports involved mainly pivoting or side-stepping therefore two participants substituted their sport with cycling to reduce their risk of re-injury. Three participants were involved in pre-injury sports imposing direct impact onto the knee. Falling onto the knee, striking with the knee (kickboxing) or a motorbike falling onto them were their concerns. Two competitive athletes felt that risk of re-injury accompanies elite level of sport, therefore were fearful of participation:

“I would never play provincially now because I’m always worried that at that level I am going to do the same damage” (66).

Three participants described a frequently performed movement, such as pivoting, as the mechanism of injury, thus fearing the resumption of the same sport. Athletes may not have been previously aware of the type of injuries that are common in particular sports.

“The interesting thing is that I didn’t actually injure myself in contact. I injured myself from bad feet positioning [after jumping]. So that’s my number one reason [for fearing re-injury], now that I’m aware of the type of injury and the type of surgery” (8).

iii. Psychological / personality traits

Six participants stated their fear of re-injury is psychological as no physical problem exists. These participants appear to have anxiety about further injury:

“If I get into a circumstance where both legs are overextended, my immediate reaction would be to retract the operated knee first. And that has almost become a reaction before I consciously think about that it’s actually fine” (32); “I think it’s just a psychological thing. It’s not really because of the leg” (36).

A competitive rugby player was advised by the surgeon to refrain from rugby in order to prevent osteoarthritis of the knee joint. However, this participant was persistent, dropping to a lower level of sport to reduce re-injury risk (66). In contrast, a pessimistic soccer player would rather terminate sport than play at a lower level (8). Competitive level athletes may lack confidence after spending time away from sport while their competitors have been consistently training (54):

“Getting to championship level is going to take a lot” (54).

The psychological effect of pain resulted in fear. Mild knee pain during everyday activities preceded an ACL injury during hockey (90). Subsequently, similar pain in the contra-lateral knee warns against resuming pivoting sport. A skier described the ACL injury as a terrible experience (6). Similarly a rugby player complained of severe pain at the time of injury, cautioning them from resuming their sport (36). Whether the ACL injury was the first major sports injury, or one of many during a long sporting career, their experience during this episode informed sufficient fear of re-injury to cause cessation of sport.

iv. Social priorities

Family commitments were a popular contributor to fear of re-injury. Because a subsequent injury would prevent fulfilment of a social role, fear of re-injury developed: *"If I now had to injure my right leg I wouldn't be able to drive for 6 weeks and with two kids at school. I can't do it"* (90).

One participant feared the financial impact of medical care should re-injury occur. A change of priorities was evident when a national level athlete declared that family time was more important. Peer pressure to play soccer caused one participant to avoid the sport completely. Unfortunately, the cessation of sport may be accompanied by regret: *"I loved the sport very much"* (44).

This regret may stem from social implications:

"The big thing is we went skiing every year as a family holiday" (6)

In contrast, one participant positively advocated that subsequent to the injury, a preferred and less threatening sport has been discovered (32). Educational commitments contributed to termination of competitive sport in one participant fearing pain (36). Advancing age informed fear of re-injury in four participants who cited "getting older" as a reason for avoiding their pre-injury sport. They were content with the time that they enjoyed their sport and were accepting of its termination, thus no longer a priority in their lives.

3.3.4 Influence of clinicians

Participants were questioned regarding their post-operative experiences and expectations of RTS. Eight of the 12 participants were told that their knee will be as strong and may RTS after completion of their rehabilitation. Two participants (both recreational) were cautioned against pivoting sport and one competitive athlete was advised to terminate sport to avoid long term degeneration the knee joint. One participant did not go back for a follow up. Three participants did not consult the prescribed physiotherapist or biokineticist which may have influenced their non RTS and/or their fear of re-injury. Five participants attended physiotherapy only, reasoning that it was better, less expensive and less intense than biokinetics, while four found biokinetics to be extremely helpful. The participants were generally content with the rehabilitation programme however four participants commented that they should have been more self disciplined with the exercise regime. Due to the large influence of the prolonged recovery time (eight participants complained of this), and four participants stating that they recovered well once strength training commenced, an accelerated rehabilitation programme may be valuable. This suggestion was made by one participant who compared his rehabilitation to that of a foreign colleague, whose strength training had commenced sooner and a better outcome was perceived by the participant.

3.4 DISCUSSION

Physical readiness to RTS after ACL reconstruction does not always correspond with psychological readiness, thus resulting in termination of sport in many athletes (Arder et al., 2012). In our study, 59% returned to the same pre-injury sport and 42% to the same pre-injury level of sport. This is in agreement with other study findings (Arder et al., 2014). Athletes undergo surgery in order to allow the resumption of sport; therefore this is an important outcome (Feller & Webster, 2013). A qualitative study by Tjong, Murnaghan, Nyhof-Young & Ogilvie-Harris (2013) investigating factors affecting the decision to RTS after ACL reconstruction, found various fears, priorities and personality types the most frequently cited reason for non-return. Factors informing their fear may be physical, such as pain and poor knee function, or non-physical, such as finance and social commitment and recovery time. In our study, interviews to discover what informs athletes' experience of fear of re-injury in those not returning to pre-injury sport have provided insight into this area that has not yet been explored.

The most commonly cited factor informing fear of re-injury in this study was undergoing surgery and the recovery process again. All these participants were male with only one being under the age of 30 years. This population may be well into an established career and time away from work is problematic. These contextual factors are non-modifiable, however partially modifiable fears are also described. Management of post surgical pain is imperative to prevent the development of fear avoidance (Tripp et al., 2007). All the participants who underwent surgery less than two months after injury were categorised into this group. We found no significant difference between times from injury to surgery subgroups, although the mean time from injury to surgery of the interviewed participants

was longer than that of the initial sample. Ardern et al., (2012) found more fear of re-injury in athletes who underwent surgery greater than three months after injury.

All the participants had a minimum pre-injury Tegner score of seven and participated in pivoting or extreme sports at a range of competitive levels. The nature of the sport induced a risk of re-injury which was perceived as too high by some participants. Appropriate health coaching using motivation and behavioural strategies may improve confidence in this group of athletes (Ardern et al., 2013). The experience of injury, whether full contact or a relatively minor incident informed fear of repeated injury. For participants wishing to RTS, practicing the feared movement has been shown to reduce fear of re-injury after ankle ligament injury and may be useful post ACL reconstruction (Larmer et al., 2011). Participants playing at a social level for fitness prior to injury may be content to change to a sport that is less threatening to the knee (Tripp et al., 2007).

Personality traits affect the psychology of athletes. Self-efficacy and personality characteristics have been found to be the most important factors influencing compliance and return to sport (Pizzari et al., 2002; Eastlack, Axe & Snyder-Mackler, 1999). Should the athletes who pre-operatively aimed to RTS slowly loose motivation, sports psychology may be valuable (Ardern et al., 2014). A final factor informing fear of re-injury was a change in social priorities and responsibilities. Personal lifestyle factors are non modifiable and changes in lifestyle are inevitable. The mean age of this group was older than the initial sample suggesting more fear in older athletes. This may be due to increased occupational or family commitments in older athletes (Ardern et al., 2014).

The influence of the clinicians and expectations of the participants may contribute to the resumption of sport. When questioned about the rehabilitation, one third of the

participants mentioned that they were not completely diligent with the exercise regime and more self discipline was needed. Length of time invested in rehabilitation should be optimised by motivating athletes to be compliant with their exercises thereby improving their outcome (Devgan et al., 2011). By interviewing those citing fear of re-injury as the stand alone reason for non-return and excluding fear associated with poor knee function and present pain, confounding is avoided. However, during the interview, two participants stated that weakness in the hamstring following harvesting of the graft created a fear of injury to the hamstring concerned. The optimal graft type has not been established (Engelman et al., 2014); however the importance of hamstring strength rehabilitation is suggested. This also highlights that overlap between function and fear of re-injury cannot be generalised to poor knee function but globally to the entire neuromusculoskeletal system. Due to the lengthy rehabilitation deterring participants from either completing the rehabilitation or informing fear of repeating the process, an accelerated rehabilitation programme could be suggested. Pre-operative education complimenting the physical rehabilitation may ensure realistic expectations, increase self efficacy and allow screening for athletes suited to an accelerated programme (Soderlund, 2011).

The demographics (age and gender) of our study are similar to other literature (Hartigan et al., 2012; Ardern et al., 2011) and were maintained in the electronic survey. The mean age of those interviewed was greater than the recruited sample and included six times as many males. It could thus be suggested that older male athletes have more fear of re-injury; however more research is required for conclusive results. Secondary outcomes showed no significant difference in return rate of males versus females which is in agreement with other literature (Lentz et al., 2012; Kvist et al., 2005) and in contrast to literature showing a greater return in males (Ardern et al., 2011). Our study shows

athletes younger than 20 years of age are significantly more likely to RTS which is in agreement with two other studies showing younger age favouring RTS (Ardern et al., 2011; Lentz et al., 2012).

Limitations of this study include reflexivity as the investigator is a physiotherapist therefore some participants may have been reluctant to criticise the rehabilitation post ACL reconstruction despite ensuring confidentiality. The age and gender of the interviewer may create social desirability bias where participants may appear more agreeable or confident in their responses, and subjectivity exists in the perceptions of responses. The investigator may have sought to standardise the responses to the questions through the guiding schedule. The patient population from two surgeons at the same hospital creates a sample bias which limits generalisability; however one assumes that the athletes arrived at the hospital randomly. Those who had returned to sport were not interviewed, thus the existence of fear of re-injury in that population has not been established.

The main strength of this study is its advantage of mixed methods which helps generalise the qualitative findings. The sample was identified quantitatively and risk ratios are in agreement with other studies. Thereafter, qualitative methods were used to interpret the findings by gaining a complex understanding in context. We have included a range of competitive levels, personality types, and personal lifestyle factors therefore improving the generalisability of the findings. A further strength is that all twelve participants eligible for the interview participated in the qualitative study. The interviewer was not involved in the rehabilitation of the participants to minimise bias.

Further qualitative research is required to establish whether fear of re-injury exists in athletes who have successfully RTS and their coping techniques, which would be valuable information to implement into clinical practice. This study explored the relationship between quantitative factors such as age, gender, time from injury to surgery and Tegner activity scale with fear of re-injury. The association of other quantitative factors with qualitative findings has not been described and further research is warranted.

3.5 CONCLUSION

Half of the athletes not returning to the pre-injury sport cited fear of re-injury as the reason. The experiences described by these 12 participants are therefore a key concern. Modifiable fears informed by pain, length of rehabilitation, mode of rehabilitation, mechanism of injury and psychological aspects can be addressed to facilitate RTS. Non-modifiable fears were related to the nature of pre-injury sport, social priorities, age and gender. Clinicians should be aware of factors informing fear of re-injury on an individual basis to develop a tailored management plan.

CHAPTER 4

Summary and Conclusion

4.1 Contribution of the study to knowledge

The distinction of RTS can be qualified as return to the *same* sport, and if so, has the same *level* of sport been resumed (Feller & Webster, 2013)? It has been demonstrated that athletes who meet functional RTS criteria may not have the ability to resume their sport (Shelbourne & Nitz, 1992). Both the systematic review and the qualitative study investigating the association of intrinsic factors with RTS, support that finding. The review found younger patients may be more likely to RTS which is in agreement with the primary study analysis where athletes younger than 20 years of age were significantly more likely to RTS. Findings regarding gender were equivocal; with male competitive athletes appearing to be more likely to return in the review and no difference was found in the primary study analysis. The most important finding of the SR is that fear of re-injury is a common reason for athletes not returning to the same type and level of sport after ACL reconstruction. When combining the primary study results with the studies reviewed, 165 athletes did not RTS. Of these, 61 athletes (37%) did not RTS due to fear of re-injury. The qualitative study is the first study discussing factors informing athletes' fear of re-injury and through semi-structured interviews, four main themes emerged. Undergoing the surgery and recovery again, nature of the pre-injury sport imposing risk of re-injury, personality traits, and social priorities all contributed to fear of re-injury. Education and psychological screening may be just as important as physical and

functional ability when meeting post-operative outcomes, particularly regarding return to sport.

4.2 Clinical implications

Fear of re-injury is proportional to knee function assessed by the IKDC score (Feller & Webster, 2013). Understandably athletes may fear re-injury if effusion, stiffness, weakness and instability persists. Re-injury occurs in 1.8%-10.4% of cases, and between 8.2%-16% of athletes rupture the contra-lateral ACL (Feller & Webster, 2013). Both the review and primary study indicate that some athletes do not RTS despite good knee function, and fear of re-injury may be the reason for the discrepancy. Thus clinicians should be aware of the existence of fear of re-injury during ACL reconstruction management.

The fear avoidance model can be applied to ACL reconstruction. Behavioural avoidance of activity results when pain from injury is perceived as a threat (Chmielewski et al., 2008). Therefore fear of pain develops into fear of re-injury. To address this issue, management of pain-related fear is important post-surgery. Prescription of adequate analgesics, management of effusion, patient education and graded exercises can be employed to prevent fear avoidance and thus avoidance of activity (Chmielewski et al., 2008).

Motivation post-injury is associated with exercise compliance and attendance of rehabilitation sessions (Chan, Lonsdale, Ho, Yung & Chan, 2009). Motivation can be improved by providing options to the patient, understanding their opinions, and explaining the rationale behind the rehabilitation protocol (Chan et al., 2009). This is an

important clinical step in improving outcome, particularly in patients who fear re-injury because the rehabilitation was incomplete. Additionally, these tools will improve self-efficacy in patients who fear the long recovery process.

Adams et al (2012) suggested that neuromuscular control of dynamic lower limb valgus is important to prevent re-injury, thus plyometric exercises should be incorporated into end-stage rehabilitation programmes. Neuromuscular training was investigated by Johnson & Beynnon (2012) and while a small insignificant improvement was found, it cannot replace strength training. This implies that multiple physical factors are required to constitute complete rehabilitation.

The suggestion of an accelerated rehabilitation programme was made by the interviewees to expedite the recovery process. A study comparing traditional and accelerated rehabilitation found those patients who progressed as they felt comfortable, rather than being restricted to traditional timelines, regained function more quickly (Shelbourne & Nitz, 1992). A SR of rehabilitation after ACL reconstruction showed equivocal results for accelerated vs. traditional rehabilitation (Johnson & Beynnon, 2012). The same review showed no difference in outcomes with bracing, however in my study, all patients were braced for six weeks.

Return to sport and minimising subsequent structural damage is the aim of reconstruction. However, if RTS rate remains challenging and prevention of osteoarthritis is arguable (Feller & Webster, 2013), eligibility for ACL reconstruction should be carefully screened. Modifiable and non-modifiable fears should be considered during the pre and post-operative management of anterior cruciate ligament reconstruction. Modifiable fears informed by the athletes' experience of pain, length of

rehabilitation, mode of rehabilitation, mechanism of injury and psychological aspects can be addressed to facilitate RTS. Awareness of non-modifiable fears informed by the nature of pre-injury sport, social priorities, age and gender is valuable.

4.3 Limitations

The systematic review (Chapter 2) includes studies assessing intrinsic factors at the time of follow up when athletes are cleared for RTS, therefore demonstrating their association, but it cannot be assumed that the modifiable factors will be predictive of RTS if assessed prior to the athletes' RTS. The review was limited to a small evidence base of ten studies. Furthermore, a meta-analysis was not possible due to heterogeneity between studies. The review could have been subjected to selection bias as titles were screened by one reviewer. In addition, only three languages were considered, thus language bias could have influenced the review findings.

Limitations of the qualitative study (Chapter 3) include reflexivity as the investigator is a physiotherapist therefore some participants may have been reluctant to criticise the rehabilitation post ACL reconstruction despite ensuring confidentiality. The age and gender of the interviewer may create social desirability bias where participants may appear more agreeable or confident in their responses, and subjectivity exists in the perceptions of responses. The investigator may have sought to standardise the responses to the questions through the guiding schedule. The patient population from two surgeons at the same hospital creates a sample bias which limits generalisability; however one assumes that the athletes arrived at the hospital randomly. Those who had returned to sport were not interviewed, thus the existence of fear of re-injury in that population has not been established.

4.4 Recommendations for future research

Due to the small evidence base, there is a paucity of studies investigating other intrinsic factors such as BMI, leg dominance, laxity and muscle strength and further research is warranted. The association of age, gender, time from injury to surgery and Tegner activity scale with fear of re-injury was described in the qualitative study. The association of other quantitative factors such as proprioception and muscle strength, with qualitative findings has not been described and further research is warranted.

Effects of an accelerated programme require more research particularly following a hamstring graft and whether graft laxity occurs (Feller et al., 2013). Investigating the effect of accelerated vs. traditional rehabilitation on RTS rate will be useful as previous study outcomes have explored the affect of an accelerated programme on knee function or activity (Shelbourne & Nitz, 1992). There is evidence that some athletes have returned to sport despite poor functioning knees (Smith et al., 2004). The way that these athletes overcame fear of re-injury is valuable information which could be used to intervene in their counterparts who have good knee function yet have not RTS. This is recommended for future research. Intervention studies to address fear of re-injury are required. The effect of a multidisciplinary approach to the rehabilitation of ACL reconstruction warrants investigation.

4.5 Conclusion

The most important finding of the systematic review was the association of fear of re-injury preventing return to sports participation. Knee function was not always associated with RTS in both studies. A better RTS rate was found in younger athletes and competitive, male athletes appeared more likely to return. Fear of re-injury was thus investigated further as it could be considered in the post-operative management of ACL reconstruction. From the participant interview exploring athletes' experiences informing fear of re-injury, four themes emerged: undergoing the surgery and recovery again, nature of the pre-injury sport imposing risk of re-injury, personality traits, and social priorities. An accelerated rehabilitation programme was suggested to improve the post-operative experience. Clinicians should be aware of factors informing fear of re-injury on an individual basis to develop a tailored management plan.

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APPENDIX

APPENDIX 1: Screening of eligibility criteria per study

1. The outcome at 15 years of endoscopic anterior cruciate ligament reconstruction using hamstring tendon autograft for 'isolated' anterior cruciate ligament rupture		
<u>Inclusion Criteria</u>		<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	From 14 years
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	???	Not specified in paper
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	???	Not Specified

2. Ardern (2011) Return to the Preinjury Level of Competitive Sport After Anterior Cruciate Ligament Reconstruction Surgery : Two-thirds of Patients Have Not Returned by 12 Months After Surgery		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >		Mean age 27.2 ± 8.4 years. No age limit specified
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		

Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	Gender
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

3. Muscle strength and function before and after anterior cruciate ligament reconstruction using semitendinosus and gracilis

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	*	patients >40 excluded
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	25 patients injured in sport 4 had diff accidents Not specified in paper
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	Pre- post-op quads & hamstrings
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	Comparison of pre – post-op function

4. Factors affecting proprioceptive recovery after anterior cruciate ligament reconstruction

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	15-40 years

Physically active patients (patients who do some form of sport/physical activity on a regular basis)	**	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	*	Proprioception
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	Not specified

5. Effect of physiotherapy attendance on outcome after anterior cruciate ligament reconstruction: a pilot study

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	No exclusion for age
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	*	Frequent physio sessions vs less frequent
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	Not specified

6. Prognosis and Predictors of ACL Reconstructions using the MOON Cohort: A Model for Comparative Effectiveness Studies

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were	✓	

considered for inclusion		
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	Nested cohort
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	*	Fear of injury predictive
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

7. Tripp et al (2007). Fear of Reinjury, Negative Affect, and Catastrophizing Predicting Return to Sport in Recreational Athletes With Anterior Cruciate Ligament Injuries at 1 Year Postsurgery		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	*	No minimum age specified. Athletes 16- 53
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

8. Gender predicts pain		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	*	Not specified
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	
Patients who has deficient ACL (copers/non-copers)	*	
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	*	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	

9. Self-efficacy, symptoms and physical activity in patients with an anterior cruciate ligament injury: a prospective study		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	prospective
Population		
Humans	✓	
Males & Females from 13 years >	*	16yrs – 60 yrs
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	**	Compares outcomes to K-SES to measure self-efficacy rather than RTS status
Outcome measure: Primary: Return to pre-injury	✓	

level Secondary: Return to level of activity lower than pre-injury		
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10.Preoperative Predictors for Noncopers to Pass Return to Sports Criteria After ACL Reconstruction

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)	✓	
Patients who underwent any ACL surgical intervention		
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	**	Measured pre-operatively, not at RTS
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

11.Effect of lower limb dominance on knee joint kinematics after anterior cruciate ligament reconstruction

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	Only mean age specified
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	Not specified
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older	*	Lower limb dominance

patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity		
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	Not specified

12. Results of Anterior Cruciate Ligament Reconstruction in the Adolescent Female

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion		
Population		
Humans	✓	
Males & Females from 13 years >	**	Females only
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	**	Comparison of operated to non-operated extremity
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

13. Outcome of anterior cruciate ligament reconstruction with emphasis on sex-related differences

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	retrospective
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	Large % of study population is physically active. Not analysed according to

		phys activity
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	gender
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	Not specified

14. Factors affecting outcome after anterior cruciate ligament injury: a prospective study with a six-year follow-up

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	*	18yrs -50yrs
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	Regular physical activity not specified
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	*	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	

15. Osti et al (2009). Surgery for ACL deficiency in patients over 50

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	

Males & Females from 13 years >	✓	2 groups (under 30 & over 50)
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

16. Comparison of outcomes between males and females after anterior cruciate ligament reconstruction

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	

17. Lee et al (2008). Return to Sports After Anterior Cruciate Ligament Reconstruction – A Review of Patients with Minimum 5-year Follow-up

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
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Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	No minimum age specified. Patient age range 18-40
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	Competitive athletes compared to recreational athletes
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

18. Sex Differences in Patient-Reported Outcomes After Anterior Cruciate Ligament Reconstruction		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	**	Not a requirement in this study
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	**	Gender compared. No reference to level of physical activity
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	**	

19. Gobbi & Francisco (2006). Factors affecting return to sports after anterior cruciate ligament reconstruction with patellar tendon and hamstring graft: a prospective clinical investigation		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	No age limits set. (17-50yrs)
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	Comparison: <ul style="list-style-type: none"> • Patellar/ Hamstring tendon graft • Knee scores between athletes who returned to sport & those who did not^{***}
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

20. Pre-operative factors predicting good outcome in terms of health-related quality of life after ACL reconstruction		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	**	
Patients who has deficient ACL		

(copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity		
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury		

21. Does Physiologic Posterolateral Laxity Influence Clinical Outcomes of Anterior Cruciate Ligament Reconstruction?

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	**	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity		
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	**	

22. Devgan et al (2011). Functional Outcome in Athletes at Five Years of Arthroscopic Anterior Cruciate Ligament Reconstruction

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	

Population		
Humans	✓	
Males & Females from 13 years >	✓	Age range 20-28. No limits set
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	Fear of re-injury
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

*23. The role of anterior cruciate ligament reconstruction in the older patients, 55 years or above		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	*	50 yrs>
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	*	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	*	

*24. Analysis of return to competition and repeat rupture for 298 anterior cruciate

ligament reconstructions with patellar or hamstring tendon autograft in sportspeople		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	No age limit
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	?	Comparison of re-injury rate
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

*25.Kvist et al (2005) Fear of re-injury: a hindrance for returning to sports after anterior cruciate ligament reconstruction		
<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	?	Inclusion criteria 16-35
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	Fear of injury

Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	
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***26. Predictors of Activity Level 2 Years After Anterior Cruciate Ligament Reconstruction (ACLR) : A Multicenter Orthopaedic Outcomes Network (MOON) ACLR Cohort Study**

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	Median age 23yrs
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	*	Not specified
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity		
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	Not specified as pre-injury sport level

***27. Knee function and Return to Sports Activity in Competitive Athletes Following Anterior Cruciate Ligament Reconstruction**

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	No age limit specified
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	

Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	**	Main findings reported on effect of surgical intervention. Comparison Quads-injured vs Uninjured
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

***28. Smith et al (2004). Subjective functional assessments and the return to competitive sport after anterior cruciate ligament reconstruction**

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	*	Exclusion criteria: <15(M), <16(F)
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

29. Ardern et al (2013). Psychological responses matter in returning to Preinjury level of sport after anterior cruciate ligament reconstruction surgery

<u>Inclusion Criteria</u>		<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		

Humans	✓	
Males & Females from 13 years >	✓	From 14 years
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	???	Not specified in paper
Patients who has deficient ACL (copers/non-copers)	✓	
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	???	Not Specified

30. Lentz et al (2012). Return to pre-injury sports participation following ACLR: contribution of demographic, knee impairment and self-report measures

<u>Inclusion Criteria</u>	<u>Criteria met Y/N</u>	<u>Comment</u>
Type of study: Cohort (prospective longitudinal), cross-sectional with or without prospective time frame, audits were considered for inclusion	✓	
Population		
Humans	✓	
Males & Females from 13 years >	✓	15-50 years
Physically active patients (patients who do some form of sport/physical activity on a regular basis)	✓	Excluded if non RTS due to social reasons
Patients who has deficient ACL (copers/non-copers)		
Patients who underwent any ACL surgical intervention	✓	
Comparison/Exposure: opp gender/older patient/strong pre-op muscle strength/no fear of re-injury/competitive sport ppl/lower BMI/low degree of laxity	✓	• Compared with RTS.
Outcome measure: Primary: Return to pre-injury level Secondary: Return to level of activity lower than pre-injury	✓	

Red font: did not satisfy eligibility criteria

Green font: satisfies eligibility criteria

APPENDIX 2: Participant Information Leaflet and Consent Form

TITLE OF THE RESEARCH PROJECT: Why Athletes May Fear Returning To Sport
after Anterior Cruciate Ligament Reconstruction

REFERENCE NUMBER:

PRINCIPLE INVESTIGATOR: Cheryl Ross

ADDRESS: Department of Physiotherapy

Francie Van Zyl Drive
Parrow
7500

CONTACT NUMBER: 082 335 5649

Dear Patient and Parent/ Legal guardian,

My name is Cheryl Ross and I am a physiotherapist working with Dr Ponky Firer and Dr Bradley Gelbart. I would like to invite you to participate in a research project that aims to investigate the underlying reasons for fear of returning to the same sport, at least one year after anterior cruciate ligament reconstruction.

Please take some time to read the information presented here, which will explain the details of this project. Please ask any questions about any part of this project that you do not fully understand. It is very important that you are full satisfied that you clearly understand what this research entails and how you could be involved. Also, your

participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

Patients over the age of 13 years who have had an ACL reconstruction 12 months or more ago was identified from those operated on by Dr Ponky Firer and Dr Bradley Gelbart. A sample of 100 patients will be e-mailed a simple questionnaire regarding return to sport after ACL reconstruction. The study aims to identify reasons for not returning to the same sport and/or the same level of sport. Following the e-mailed questionnaire, you may be required to participate in a brief telephonic interview to further discuss the reasons for fear of reinjury. The role of physiotherapy during the rehabilitation may also be discussed to identify any areas we could possibly change.

Why have you been invited to participate?

You have been identified as one of Dr Ponky Firer/Dr Gelbart's patients who had an ACL reconstruction 12 months or more ago and therefore able to participate in this study.

What will your responsibilities be?

You are expected to fill in the tick box questionnaire and return it to me by the stipulated date and be available for a brief telephone call thereafter if necessary.

Will you benefit from taking part in this research?

The most important benefit is aiding future patients also undergoing an ACL reconstruction and the clinicians treating these patients.

Are there risks involved in your taking part in this research?

There are no risks involved in your taking part.

Who will have access to your medical records?

During the research, the primary researcher will have access to your medical records at Dr Ponky Firer and Dr Bradley Gelbart's rooms. The primary researcher, research assistant and supervisor will have access to your information extracted from the files regarding age, gender and contact details and the results of the questionnaires. Names will immediately be replaced by numbers. Upon completion the research will be presented at the university academic year day. All information will be anonymous and confidentiality will be protected at all times.

By agreeing to participate in this study, you declare that:

- I have read the information leaflet and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered

- I understand that taking part in this study is voluntary and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

As a parent or legal guardian:

- I have read the information leaflet and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered
- I consent to my child participating in this study

If you are willing to participate, please continue by ticking the boxes in the attached questionnaire.

Yours sincerely,

Cheryl Ross

Principle Investigator

APPENDIX 3: Electronic Survey

*** questions require an answer before being allowed to proceed.**

***1. I have read the information leaflet and consent to participate**

☐ Yes

2. What type of sport did you participate in before you ACL injury?

3. Did the injury occur during this sport?

☐ Yes

☐ No

***4. Have you returned to the same sport?**

☐ Yes

☐ No

***5. Have you returned to the same level of sport (same or different sport)?**

☐ Yes

☐ No

6. If you answered “No” to question 4 or 5 above, please select which reason(s) are most applicable to you:

☐ Is the reason for not returning a problem with knee function e.g.: pain, instability and/or weakness?

☐ Is the reason for not returning due to fear of re-injury of your operated knee or fear of injuring your other knee?

☐ Is the reason for not returning something other than the knee e.g.: further studies, marriage, money, change in social activities or other?

Other (please specify)

7. Are you satisfied with the outcome of the surgery?

___ Yes

___ No

8. Confirm your phone number a request a time of call that will be most suitable should a telephonic interview be required.

Phone number _____

Time of call _____

APPENDIX 4: Guiding Questions for Telephonic Interview

Hi X, this is Cheryl speaking. I am the physio doing research on knee outcomes after ACL surgery. You completed my electronic survey, thank you very much. I would like to chat to you for a few more minutes about your knee. Is that okay and can we chat now?

Thank you. Can you confirm which sport you participated in before your knee injury?

Did the injury occur during [your sport]?

At what level were you participating? Recreational or competitive?

Have you returned to [your sport] since the surgery?

Are there any specific reasons for not returning [competitively] yet?

Do you do any other sport or exercise at the moment?

And is that at a recreational or competitive level?

Okay. In the questionnaire you said that fear of reinjury has prevented returning to [your sport]. Could you explain to me what you meant a bit more?

If offers a reason for fear – find out more: clarify, explain, why?

Are there any other aspects of your sport that makes you fearful?

Can you tell me about your experiences with receiving physio and Biokinetics?

Explore answer. Tell me more

Is there something the physio or biokineticist could have done better which would have lessened your fear of re-injury?

Could you elaborate on this?

What were your expectations about sport after surgery?

Was the possibility of reinjury discussed with you?

Summarise or recap the main points.

Is there anything else you would like to add?

Thank you very much for your feedback.

APPENDIX 5: Tegner Activity Scale

BEFORE INJURY: Level_____ CURRENT: Level_____

Level 10	sports- soccer, football, rugby (national elite)
Level 9	Competitive sports- soccer, football, rugby (lower divisions), ice hockey, wrestling, gymnastics, basketball
Level 8	Competitive sports- racquetball or bandy, squash or badminton, track and field athletics (jumping, etc.), down-hill skiing
Level 7	Competitive sports- tennis, running, motorcars speedway, handball Recreational sports- soccer, football, rugby, bandy, ice hockey, basketball, squash, racquetball, running
Level 6	Recreational sports- tennis and badminton, handball, racquetball, down-hill skiing, jogging at least 5 times per week
Level 5	Work- heavy labour (construction, etc.) Competitive sports- cycling, cross-country skiing, Recreational sports- jogging on uneven ground at least twice weekly
Level 4	Work- moderately heavy labour (e.g. truck driving, etc.)
Level 3	Work- light labour (nursing, etc.)
Level 2	Work- light labour Walking on uneven ground possible, but impossible to back pack or hike
Level 1	Work- sedentary (secretarial, etc.)
Level 0	Sick leave or disability pension because of knee problems

APPENDIX 6: Letter and signed consent by Dr Firer and Dr Gelbart

3 February 2014

Dear Dr Ponky,

Following a systematic review of intrinsic factors associated with return to sport after ACL reconstruction, the impact of fear of re-injury was highlighted as the most significant finding. I would like to pursue this in a primary qualitative study where patients are contacted and questioned about their return to sport with particular focus on those not returning due to fear of reinjury. I aim to investigate the cause of their fear and determine whether a change in physiotherapy role or rehabilitation protocol will influence their fear of reinjury.

In order to collect my patient sample, I would like to access patient files of those who had an ACL reconstruction greater than 12 months ago. The files will be screened according to the eligibility criteria. This includes males and females aged 13 years and older that injured their ACL during sport and underwent an ACL reconstruction using either a hamstring or patellar tendon autograft or allograft with or without meniscus repair. From these files, name, age, gender, date of surgery and contact details will be extracted. The eligible participants will be sent an e-mail with a short tick-box questionnaire. From the results of that questionnaire, the patients not returning due to fear will be identified and a telephonic questionnaire conducted. Confidentiality will be ensured and informed consent obtained.

I would greatly appreciate accessing your patient files for this study.

Kind regards,

Cheryl Ross

By signing below, I Dr Ponky Firer consent to Cheryl Ross accessing the patient files of those patients meeting the inclusion criteria which are required to fulfil her research according to the procedure described.

Signed at Johannesburg on 3rd Feb 2014.

[Signature]

Dr Ponky Firer

3 February 2014

Dear Dr Bradley Gelbart,

Following a systematic review of intrinsic factors associated with return to sport after ACL reconstruction, the impact of fear of re-injury was highlighted as the most significant finding. I would like to pursue this in a primary qualitative study where patients are contacted and questioned about their return to sport with particular focus on those not returning due to fear of reinjury. I aim to investigate the cause of their fear and determine whether a change in physiotherapy role or rehabilitation protocol will influence their fear of reinjury.

In order to collect my patient sample, I would like to access patient files of those who had an ACL reconstruction greater than 12 months ago. The files will be screened according to the eligibility criteria. This includes males and females aged 13 years and older that injured their ACL during sport and underwent an ACL reconstruction using either a hamstring or patellar tendon autograft or allograft with or without meniscus repair. From these files, name, age, gender, date of surgery and contact details will be extracted. The eligible participants will be sent an e-mail with a short tick-box questionnaire. From the results of that questionnaire, the patients not returning due to fear will be identified and a telephonic questionnaire conducted. Confidentiality will be ensured and informed consent obtained.

I would greatly appreciate accessing your patient files for this study.

Kind regards,

Cheryl Ross

By signing below, I Dr Bradley Gelbart consent to Cheryl Ross accessing the patient files of those patients meeting the inclusion criteria which are required to fulfil her research according to the procedure described.

Signed at Linkfield on 3 / 2 / 2014.


.....

Dr Bradley Gelbart

APPENDIX 7: Ethics Approval



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Approval Notice New Application

26-Mar-2014
Ross, Cheryl CA

Ethics Reference #: S14/02/032

Title: Why sports participants who had and ACL reconstruction may fear returning to sports participation and the implications for management.

Dear Ms Cheryl Ross,

The New Application received on 18-Feb-2014, was reviewed by members of Health Research Ethics Committee 1 via Minimal Risk Review procedures on 13-Mar-2014 and was approved.

Please note the following information about your approved research protocol:

Protocol Approval Period: 26-Mar-2014 -26-Mar-2015

Please remember to use your protocol number (S14/02/032) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at 0219389657.

Included Documents:

HREC Application form
CV A Clifford
Investigator declaration QLouw

APPENDIX 8: Format guidelines for the International Journal of Sports Medicine

Instructions for Authors

Scope of the Journal

The *International Journal of Sports Medicine* (IJSM) provides a forum for the publication of papers dealing with basic or applied information that will advance the field of sports medicine and exercise science and offer a better understanding of biomedicine.

The following sections define the scope of the journal: Training & Testing; Orthopaedics & Biomechanics; Clinical Sciences; Nutrition; Behavioural Sciences; Physiology & Biochemistry; Immunology; Genetics & Molecular Biology.

General Policy

The journal publishes original papers, reviews, and letters to the editor. Manuscripts submitted to the journal must contain novel data on theoretical or experimental research or on practical applications in the field of sports medicine and exercise science. Purely descriptive studies that lack generalisability to the wider world of sports medicine will be assigned a low priority and may not be entered by a corresponding editor into the peer review process. Intervention studies which lack a comparator group and/or are very inconsistent with the CONSORT guidelines may also be assigned a low priority and not entered for peer review. Studies that employ data analysis approaches that are obviously inappropriate will also be assigned a low priority and not entered for peer-review, as will studies in which the clinical/practical significance of the findings has not been quantified and/or communicated. The paper must also be written in grammatically correct English; otherwise it may be refused for review. No substantial part of the

submission should have been published elsewhere. If a part of the submission has been published or presented at a congress, symposium, or national meeting proceeding, the reference for that publication and/or presentation should be given in the manuscript acknowledgement section. Submitted papers undergo peer reviewing by two independent reviewers. Authors may suggest names and full addresses including telephone and FAX numbers of two reviewers but not from their own institution. Authors are required to conduct their research ethically according to international standards and as required by the journal as described in Harriss DJ, Atkinson G. Ethical Standards in Sport and Exercise Science Research: 2014 Update. *Int J Sports Med* 2013; 34: 1025–1028. Authors are expected to clearly state in the Methods section – by citing the aforementioned publication- that the study meets the ethical standards of the journal.

Categories of articles accepted for review

Original articles: Theoretical or experimental (basic or applied) research or practical applications. Either original work or the replication of work that better establishes basic principles will be considered. Original articles should not exceed a total of 15 000 characters, including references.

Review articles: Review articles on topics of broad interest are desirable. Authors who wish to submit an unsolicited review article should correspond with the editors-in-chief to determine the timeliness of the proposed review article. The correspondence should include an abstract and a complete outline of the proposed review article, including figures and tables (if possible). Review articles should not exceed 30 000 characters, including references. Review articles are considered by the editors and expert reviewers before a final decision regarding publication is made.

Letters to the editor are welcome and will be published if appropriate. Letters (maximum length 700 words) relating to material previously published in IJSM should be submitted

within 6 months after publication of the material the letter is referring to. Such letters will be sent to the corresponding author for comment within six weeks. The original letter and any reply will be published concurrently. Letters to the editor are excluded from online submission and should be sent to the editorial office at ijsm.editorialoffice@thieme.de

Submission of manuscripts

Manuscripts can be submitted exclusively via online submission at <http://mc.manuscriptcentral.com/IJSM> or via link at www.thieme.de/sportsmed. **Hard copy submission and electronic submission via email are not accepted.** See below under “Uploading files on submission” for further information on the online submission process.

Style: Manuscripts may be rejected without review on the basis of poor English or lack of conformity to stated standards of style.

Title: The title should be concise but informative.

First page: Names and addresses of the authors should not appear on the first page or elsewhere in the main document. These data are entered separately in the online submission system.

Abstract: The abstract should be informative. It should be self-explanatory without reference to the text of the manuscript. It should include essential significant results that support the conclusion of the work. Three to six key words not used in the title should also be provided (these can be entered during the online submission). Abbreviations should not be used in the abstract.

Introduction: Should be comprehensible to the general reader. Give a clear statement of the purpose of the paper and provide relevant context to support the basis for the paper and the significance of the work. Do not exhaustively review the literature.

Materials & Methods: Provide sufficient information in the text or by reference to other work to permit the submitted work to be repeated without the need to communicate with the authors. Relevant validity and reliability data should be provided for critical methods. State the type of statistical tests used. Include the number of observations and the statistical findings when appropriate. Parametric and non-parametric statistics must be used as appropriate.

Results: Should be presented precisely and should not contain material that is appropriate in the discussion. Units, quantities, and formulas should be expressed according to the Système Internationale (SI units). All measurements should be given in metric units.

Discussion: Emphasize the new and important aspects of the study and conclusions derived from the study.

Acknowledgements: Financial support should be stated.

References: References should be cited in the text by number and compiled alphabetically at the end of the article and numbered accordingly. Titles of journals should be abbreviated according to the latest edition of Index Medicus. All authors should be named (do not use “et al.”). Authors bear complete responsibility for the accuracy of the references.

Information for Authors

Script (title, full names referenced by Arabic superscripts with affiliation and addresses of all authors, and also, the complete list of references, footnotes, figure legends, and tables). **The author submitting the manuscript will be corresponding author.** Upload as many files as needed for your manuscript. **If you have updated a file, please delete the previous version and upload the revised file.** If you are submitting a revision, please include only the latest set of files. All files will be combined into a single

PDF document for the peer review process. When uploading your manuscript, you are required to select the

File designation:

Main document. The main document should be in Word format. It should not include any figures or tables.

Figures and tables. Each one should be uploaded separately. Images should be uploaded as .tif or .jpg files in a resolution of 300 dpi. Tables should be uploaded either as Word or Excel files. When uploading, a form appears requesting the following information:

- *File tags:* Please enter the figure/table number e. g. Figure 1a, Table 1
- *Caption/legend:* Please enter the figure/table number plus legend

Figure legends should be brief, but must contain all the information to make the illustration comprehensible without taking recourse to the text. Please do not upload PDFs! To designate the order in which your files appear, use the dropdowns in the “order” column.

Galley proofs and proof-reading

A PDF file of the galley proofs will be sent via e-mail to the corresponding author for proof reading. Proof reading is for typesetting errors only. At this stage the manuscript cannot be changed. The galley proofs should be returned to the appropriate address within 48 hours so the publication of the submission is not delayed.

Page charge

Together with the galley proofs, if the manuscript is more than three printed pages, the corresponding author will be asked by the publisher to submit a check or purchase order to pay the cost of publication. Up to three printed pages of publication are without charge

to the corresponding author. Each printed page beginning with the fourth printed page will carry a page charge of € 160. - (including 19% VAT). PDF for personal use; the corresponding author will receive a PDF of the published article free of charge for personal, non-commercial use only.

Only published or “in press” papers or books may be cited in the reference list. Information from manuscripts submitted but not yet accepted should be cited in the text as “unpublished observations” in parentheses. Personal communications should be listed in the text in parentheses. Published abstracts must not be used as references. Use of a large number of abstracts or non peer-reviewed articles in the reference section will be grounds for rejection of the submission without review.

Examples of references

Journal article:

1 *Palmer GS, Dennis SC, Noakes TD, Hawley JA*. Assessment of the reproducibility of performance testing on an air-braked cycle ergometer. *Int J Sports Med* 1996; 17: 293–298

Complete book:

1 *Dingle JT* (ed). *Lysosomes*. New York: American Elsevier, 1972: 65

Chapter of a book:

1 *Zancetti A, Baccelli G, Guazzi M, Mancina G*. The effect of sleep on experimental hypertension. In: *Onesti G, Kim KE, Moyer JH* (eds). *Hypertension: Mechanisms and Management*. New York: Grune & Stratton, 1973: 133–140

Figures: Before publication of any images in which the patient’s identity may be recognized, the author of the article must provide the publisher with the patient’s written consent to publication of the respective image. Standard letters for obtaining this consent are available on request from the publisher. Figures, illustrations, or half-tones should be used when findings are best visually communicated. The use of photographs

or equipment and experimental subjects should be avoided; good line drawings are more informative. Abbreviations used in the figure must be explained in the legend. Reference to the figure should be made in the text. Figures, illustrations or half-tones must be sharp and high-contrast. Uniform typographical setup (font style and size, line thickness) of all figures in a paper is highly desirable. Images should be provided as .tif or .jpg files in a resolution of 300 dpi. Colour figures, illustrations or half-tones will not be published unless the author requires colour in the publication. In this case the author will be charged with the additional cost of printing.

Tables: Tables should be used to communicate information that is hard to present visually. Results whose interpretation is more easily comprehended by knowing the means and SEM (or SD) may be presented in a table(s). Tables should be self-explanatory and bear a short title. Table legends should be typed on the same sheet as the table as a header. A footnote to the table should explain all abbreviations used in the table. Tables should be provided either as word or excel files.

Uploading files on submission

For submission of all manuscripts, follow the instructions of the online submission system at <http://mc.manuscriptcentral.com/IJSM>. Before submission, keep ready full metadata of the manuscript.

APPENDIX 9: Format guidelines for Physical Therapy in Sport

The following Instructions for authors are supplied online:

<http://www.elsevier.com/authors>

Submission of Manuscripts

The *Physical Therapy in sport journal* offers authors two choices on how to publish their research;

1. Open Access

- Articles are freely available to both subscribers and the wider public with permitted reuse
- An Open Access publication fee is payable by authors or their research funder.

2. Subscription

- Articles are made available to subscribers as well as developing countries and patient groups through their access programs (<http://www.elsevier.com/access>)
- No Open Access publication fee.

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text and data mine the article, as long as they credit the author(s), do not represent the author as endorsing their adaptation of the article, do not modify the article in such a way as to damage the authors honour or reputation, and license their new adaptations or creations under identical terms (CC BY NC SA).

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<http://www.elsevier.com/fundingbodies>

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The following information of the Author designated as corresponding Author must be stated: E-mail address; full postal address; Telephone and fax numbers; all necessary

fields have been uploaded; Keywords; All figure captions; all tables (including title, description, footnotes)

At the end of the paper (before the references) three statements must be provided:

- Ethical Approval: The organisation providing ethical approval and ethics protocol reference number where appropriate.
- Funding: any sources of funding should be stated.
- Conflict of Interest: Disclosed conflicts will be published if they are believed to be important to readers in judging the manuscript. If there are no conflicts of interest, authors should state that there are none.

Format/Preparation Guidelines

The article should be typed on A4 paper, double-spaced with margins of at least 3cm. All pages must be numbered consecutively beginning with the title page. Papers should be set out as follows, with each section beginning on a separate sheet: **Title page; abstract; keywords, text, and references.**

Parts of manuscript:

- Title page must consist of the following:
 - *Title*. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
 - *Author names and affiliations*. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the

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